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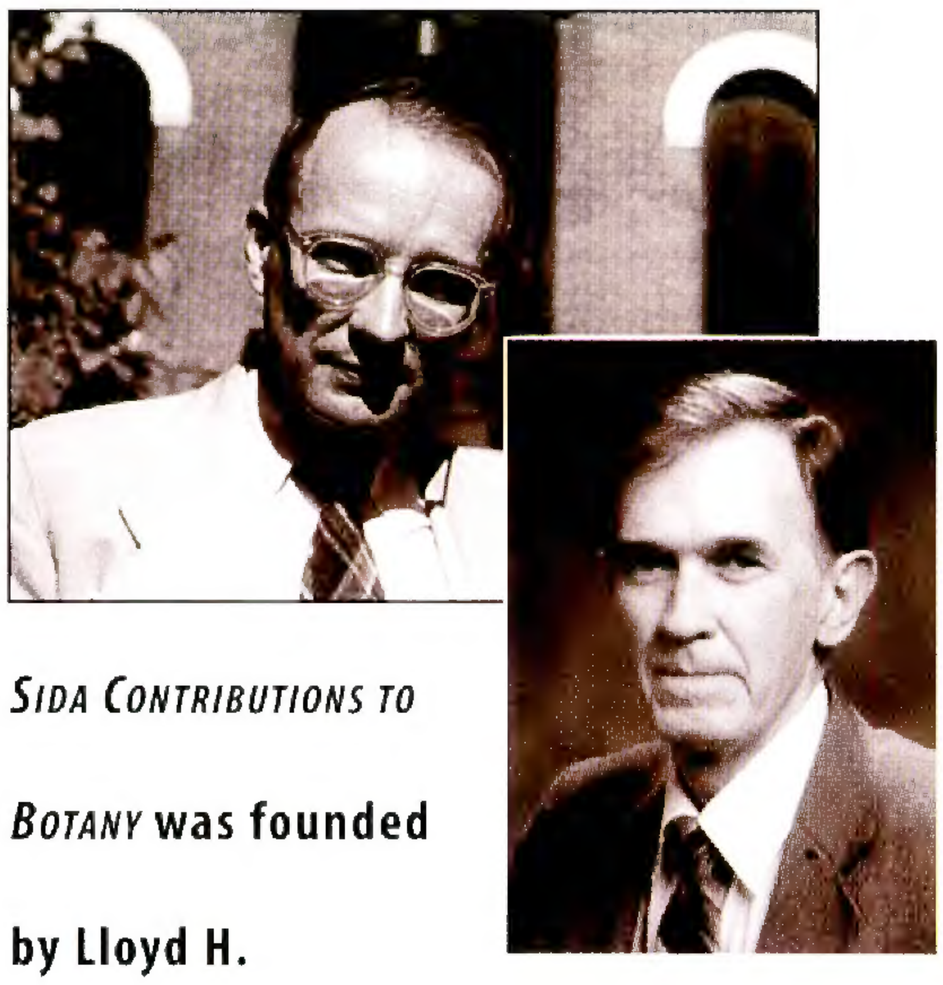
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KEY TO THE SPECIES OF ERICACEAE OF BOLIVIA, INCLUDING TWO NEW SPECIES

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ABSTRACT

A review of the Ericaceae of Bolivia is herein presented. Nineteen genera and 53 species are native; two genera and 19 species are endemic; 18 additional species are shared by Bolivia and adjacent Peru; one species is occasionally cultivated. Most taxa are found in the wet, cool habitat, montane "Yungas" of the eastern slopes of the Cordillera Real, ranging between 2000 m and 4000 m elevation. **Siphonandra boliviana** Luteyn and **Themistoclesia unduavensis** Luteyn are described and illustrated. A key in English and Spanish to the 19 genera and 53 native species is provided. The names of all taxa of Ericaceae attributed to Bolivia are accounted for.

RESUMEN

Se presenta una reseña de las especies de Ericaceae de Bolivia. Diez y nueve géneros y 53 especies son nativas; dos géneros y 19 especies son endémicas; 18 especies adicionales son compartidas por Bolivia y la parte adyacente de Perú; una especie es cultivada ocasionalmente. La mayoría se encuentra en hábitats montañosos, húmedos y fríos de las "Yungas" de la vertiente oriental de la Cordillera Real, entre 2000 y 4000 m de elevación. También se describen y se ilustran *Siphonandra boliviana* Luteyn y *Themistoclesia unduavensis* Luteyn. Se presenta una clave en inglés y en español para los 19 géneros y las 53 especies nativas. Los nombres de todos los taxones de Ericaceae atribuidos a Bolivia están justificados.

INTRODUCTION

The Ericaceae are a large, cosmopolitan family of over 125 genera and 4500 species, which inhabit the temperate regions of the world and montane areas in tropical latitudes (Luteyn 1998, in press). In the Neotropics, the Ericaceae are composed of 46 genera (70% endemic) and about 800 species (ca. 94% endemic), although generic limits in the Andean Vaccinieae are still poorly understood (Kron et al. 2002; Luteyn 1997, 2001). Neotropical Ericaceae are an Andean-centered family, adapted to moist, open, cool montane environments. Overall species richness in the Neotropics increases nearer the Equator, with the highest species numbers concentrated in Colombia and Ecuador between 1000 m and 3000 m. Nineteen genera and 53 species are native to Bolivia. Two of those genera and 18 of the species are endemic, while 18 additional species have ranges that overlap between Bolivia and adjacent Peru and one species range overlaps between Bolivia and extreme northwestern Argentina; one species is occasionally cultivated. In Bolivia, the Ericaceae occur almost exclusively in the wet,

cool, montane cloud forests, mostly in the "Yungas" regions of the eastern slopes of the Cordillera Real, ranging between 2000 m and 4000 m elevation. One of these species (*Satyria neglecta*) ranges primarily below 1000 m elevation, 12 species range primarily between 1000 m and 2000 m, 18 species range primarily between 2000 m and 3000 m, and 20 species range primarily between 3000 m and 4000 m. *Agarista boliviensis* and *Gaylussacia cardenasii*, in contrast, occur in relatively dry montane regions in south-central Bolivia at about 1200-2500 m elevation. Although Bolivia is a very large country within the Neotropics, it lies at the southern end of the distributional range of the family and many of its mountainous regions are dry. Therefore, relatively few Ericaceae occur in Bolivia compared to countries in the Northern Andes and adjacent southern Mesoamerica. There are no economic uses known for the Ericaceae of Bolivia.

There are very few general publications about the flora of Bolivia and only the out-dated checklist of Foster (1958) gives an idea of the numbers of species of Ericaceae that occur there. Killeen et al. (1993) is misleading for Ericaceae, since virtually all the taxa in Bolivia are shrubs not trees. There is, however, a project currently being organized by the Missouri Botanical Garden in collaboration with all the major herbaria in Bolivia and the New York Botanical Garden that has begun a modern checklist of the plants of Bolivia. With regards to the Ericaceae of Bolivia, only the larger overall treatment of the tribe Thibaudieae (=Vaccinieae) by A.C. Smith (1932) gives details of some of the Bolivian blueberries. The most up-to-date list of Ericaceae of Bolivia, along with some descriptions and photos, may be found on the website "Neotropical Blueberries" (Luteyn 1998). A list of all species of Ericaceae attributed to Bolivia, including the current status of names given by Foster (1958), is herein presented in an Appendix. The largest herbarium collection of Ericaceae in Bolivia is found in La Paz, at the National Herbarium (LPB); there is also a moderate sampling in Cochabamba (BOLV). The geographical regions of Bolivia in greatest need of more collecting and with greatest possibilities for more Ericaceae records would be the areas northeast of La Paz towards the frontier with Peru.

Neotropical Ericaceae, in general, have undergone dynamic speciation and extensive adaptive radiation due to their ecological and life-form plasticity, colonization abilities, adaptation to epiphytic habits, and co-evolution with hummingbirds (Luteyn 2002). Given the high diversity and endemicity within neotropical Ericaceae, along with high levels of habitat alteration, protection of Andean montane ecosystems should become a priority for their conservation.

FAMILY DESCRIPTION AND KEYS TO THE BOLIVIAN SPECIES OF ERICACEAE

ERICACEAE

Terrestrial or epiphytic *shrubs*, *subshrubs*, sometimes lianoid, rarely trees, often rhizomatous; indumentum when present of simple unicellular hairs, that are usually translucent or whitish, these sometimes glandular tipped, or often (es-

pecially on leaves beneath) of multicellular, multiseriate, swollen-headed, usually glandular, hair-like structures called fimbriae which are brownish to reddish-brown. *Leaves* alternate, simple, usually petiolate, exstipulate but rarely bud scales appearing pseudostipular; lamina coriaceous to membranous, evergreen, the margin usually entire but sometimes serrulate-crenate, the venation pinnate or plinerved; leaf scars usually with a single vascular bundle scar, nodes usually with one trace and one gap. *Inflorescences* axillary, racemose, paniculate, fasciculate, or flowers solitary; individual flowers pedicellate or rarely sessile in axils of small or large, deciduous or persistent floral bracts; pedicel bibracteolate; bracteoles persistent, small or large. *Flowers* bisexual, actinomorphic or slightly zygomorphic, 5(–7)-merous, obdiplostemonous, hypogynous or epigynous and with a biseriate perianth, typically without floral odors, rarely with extrafloral nectaries, the superior-ovaried genera pollinated by bees and the inferior-ovaried genera by hummingbirds; aestivation valvate, imbricate, or reduplicate; calyx continuous or articulate with the pedicel, synsepalous, the sepals rarely fleshy and accrescent to the fruit, the hypanthium when present terete, angled, or winged; corolla membranous to thick-carnose, polypetalous or more commonly sympetalous, cylindric, campanulate or urceolate, terete or angled to winged opposite the lobes; stamens 8–10(–14), in 2 whorls, usually twice as many as the petals or rarely just as many, equaling the corolla in overall length or 1/2–1/3 the corolla length, equal with each other or alternately unequal, borne on the edge of an obscure to prominent nectariferous disc; filaments equal or unequal, usually straight or rarely S-shaped (geniculate), ligulate but sometimes basally dilated, sometimes also basally papillose, distinct or connate, with or without spurs, shorter or longer than the anther; anthers inverting during development, 2-celled, equal or unequal, often distally with 2 distinct or connate tubules or terminal awns, sometimes provided with abaxial spurs; disintegration tissue present or lacking; thecae smooth to coarsely granular, the base rounded to apendiculate; tubules when present conical and rigid or cylindric and flexible, of equal or ca. 1/2 the diameter of the thecae, longer to shorter than the thecae; dehiscence introrse by longitudinal or more typically by apical to subapical clefts or pores, rarely perfectly terminal; pollen grains in tetrahedral tetrads; carpels 4–5(–10), fused; ovary superior or inferior, usually with as many locules as carpels or with twice as many locules as carpels or rarely loculate in lower portion and 1-locular above; placentation axile, rarely intruded parietal; ovules numerous per locule or rarely solitary, anatropous to campylotropous with a single integumentary layer; style single, fluted, hollow; stigma simple but occasionally weakly lobed. *Fruit* a loculicidal or septicidal capsule, berry, or drupe, with a usually persistent, rarely accrescent and fleshy calyx; seeds small, ca. 1–1.5 mm long, usually numerous (1 per locule in *Gaylussacia*), winged or tailed only in *Bejaria*, sometimes enclosed in a mucilaginous sheath, the testa thin with elongated or isodiametric cells, the en-

dosperm fleshy, the embryo straight, usually white or sometimes green. *Chromosome numbers*: **x**=6, 8, 11, 12(?), 13, 19, 23.

Ericaceae comprise ca. 125 genera and 4500 species worldwide, and are cosmopolitan with the exception of Antarctica. Nineteen genera and 53 species are native to Bolivia. *Rhododendron simsii*, native to China, is sometimes cultivated in the montane areas throughout the Neotropics (including Bolivia), but is not treated here.

ENGLISH KEYS

Notes on using the keys

The keys below are based primarily on herbarium specimens, although living (*in situ* and greenhouse-grown plants), alcohol-preserved material, and photographs taken from field or greenhouse-grown material have been used. Floral measurements are taken from herbarium material at anthesis unless otherwise stated; colors are from fresh material observed by the author unless otherwise stated; if a range of measurements is not available, the known measurement is preceded by the abbreviation "ca." (about); calyx limb length includes measurement of the lobes, and anther length includes thecae and tubules.

KEY TO THE SPECIES OF BOLIVIAN ERICACEAE WITH SUPERIOR OVARIES

1. Corolla with petals separate; fruit a septicidal capsule _____ **Bejaria aestuans**
1. Corolla with petals fused; fruit a loculicidal capsule or berry.
   2. Stamens with filaments geniculate; anthers without terminal awns, and without white disintegration tissue on abaxial side _____ **Agarista boliviensis**
   2. Stamens with filaments straight; anthers with terminal awns, and with white disintegration tissue on abaxial side.
      3. Fruit a berry, rarely calyx becoming fleshy at base but never surrounding the berry _____ **Pernettya prostrata**
      3. Fruit a capsule, surrounded by the fleshy, accrescent calyx (calyx rarely not fleshy).
         4. Flowers solitary in axils of normal (or only slightly reduced) leaves.
            5. Thick-stemmed shrub to 5 m tall; corolla campanulate, broadest at apex, yellowish-green _____ **Gaultheria buxifolia** var. **secunda**
            5. Thin-stemmed subshrub to 0.4 (rarely 1–2) m tall; corolla urceolate to nearly subglobose, inflated at the base and very constricted at the throat, pink to rose-red _____ **Gaultheria vacinioides**
         4. Flowers in axillary racemes.
            6. Abaxial surface of lamina and entire inflorescence tomentose-lanate _____ **Gaultheria eriophylla** var. **mucronata**
            6. Abaxial surface of lamina and inflorescences glabrous or sparsely to densely pubescent but never tomentose-lanate.
               7. Young twigs and inflorescences conspicuously strigose with straight, rigid, appressed hairs, usually so dense as to obscure surfaces; lamina usually densely and persistently reddish-strigose beneath.
                  8. Calyx glabrous; corolla glabrous to variably hairy, never densely strigose all over; ovary glabrous or very weakly short-pilose at apex;

inflorescence congested (glomerate) at anthesis with the flowers broadly overlapping _____ **Gaultheria glomerata**

8. Calyx and corolla densely strigose hirsute with ferruginous, subsetose, rarely glandular hairs; ovary densely short-white pilose or cinerous; inflorescence not congested at anthesis, the flowers widely spaced _____ **Gaultheria bracteata**

7. Young twigs and inflorescences glabrous or variously spreading pubescent, but not appressed-strigose with straight, rigid hairs; lamina glabrous or variously pubescent, but not strigose beneath.
   9. Repent, rhizomatous subshrub, 0.1–0.2 m tall; leaf lamina usually obovate with the apex rounded _____ **Gaultheria hapalotricha**
   9. Erect, subshrubs to shrubs, 0.1–8 m tall; leaf lamina various but only rarely obovate, the apex usually acute to acuminate.
      10. Leaf lamina usually distinctly and prominently reticulate-veined on **both** surfaces, the base usually acute to rounded; inflorescences clustered at branch tips and conspicuously exceeding the leaves in length; calyx and corolla eglandular; corolla white, pilose within _____ **Gaultheria reticulata**
      10. Leaf lamina not conspicuously reticulate-veined on both surfaces, the base usually rounded and deeply cordate; inflorescences scattered along branches, not exceeding leaves; calyx and corolla often glandular pubescent; corolla red, glabrous within _____ **Gaultheria erecta**

KEY TO THE SPECIES OF BOLIVIAN ERICACEAE WITH INFERIOR OVARIES

1. Stamens strongly unequal with filaments or anthers, **or** filaments and anthers alternately conspicuously unequal.
   2. Filaments equal and connate over entire length; anthers with tubules widening distally.
      3. Leaves elliptic-lanceolate, 6–10 cm long, 1.5–3 cm broad, basally obtuse to rounded, 3-plinerved; inflorescence densely pilose (except corolla); pedicels 16–21 mm long; corolla ca. 11 mm long _____ **Satyria boliviana**
      3. Leaves elliptic-oblong, 3–6 cm long, 1.2–1.8 cm broad, basally cuneate to subattenuate, pinnately veined; inflorescence glabrous; pedicels 6–12 mm long; corolla ca. 6 mm long _____ **Satyria neglecta**
   2. Filaments unequal, distinct or partially connate; anthers with sides parallel, not widening distally.
      4. Anthers equal; stamens 1/2–1/3 as long as corolla; floral bracts rarely large and showy but if so then early deciduous.
         5. Leaves pinnately veined _____ **Orthaea pinnatinervia**
         5. Leaves plinerved.
            6. Stems, petioles, leaves, rachis, pedicels, and corolla pilose _____ **Orthaea rusbyi**
            6. Plants essentially glabrous.
               7. Corolla 11–12 mm long _____ **Orthaea constans**
               7. Corolla 15–33 mm long.
                  8. Staminal filaments distinct.
                     9. Rachis 3–5 cm long; pedicels 8–13 mm long _____ **Orthaea weberbaueri**
                     9. Rachis ca. 1 cm long; pedicels ca. 7 mm long _____ **Orthaea ignea**
                  8. Staminal filaments connate.

10. Staminal dehiscence by terminal or subterminal pores _____ **Orthaea boliviensis**

10. Staminal dehiscence by lateral clefts _____ **Orthaea ferreyrae**

4. Anthers unequal; stamens as long as corolla or rarely 1/2–2/3 the corolla length; floral bracts usually large and showy, usually persistent through anthesis.
    11. Inflorescence a panicle _____ **Cavendishia martii**
    11. Inflorescence a raceme.
        12. Calyx densely woolly, the matted hairs persistent; leaves persistently soft-pilose beneath _____ **Cavendishia pubescens**
        12. Calyx glabrous to pilose, but never woolly and the hairs never matted; leaves glabrous to glabrate _____ **Cavendishia bracteata**

1. Stamens equal with filaments and anthers of equal lengths (rarely anthers inconspicuously alternately unequal).
    13. Bracteoles located at apex of pedicel, and surrounding calyx (and sometimes lower corolla).
        14. Leaves less than 5 mm broad.
            15. Corolla campanulate-cylindric, 10–14 mm long, white sometimes tinted with pink _____ **Disterigma pernettyoides**
            15. Corolla subcylindric to somewhat urceolate, 6 9 mm long, red _____ **Disterigma empetrifolium**

        14. Leaves more than 5 mm broad.
            16. Corolla 10–12 mm long, narrowly cylindric, red _____ **Disterigma pallidum**
            16. Corolla 4.5–7.5 mm long, subcylindric to ovate-urceolate, white to red.
                17. Flowers 4 merous; corolla subcylindric, rarely puberulous within; staminal filaments distinct _____ **Disterigma alaternoides**
                17. Flowers usually 5 merous (sometimes 4-merous); corolla ovate-urceolate, conspicuously pilose within; staminal filaments coherent at base _____ **Disterigma ovatum**

    13. Bracteoles located well below apex of pedicel, **or** if apical then not clasping calyx.
        18. Tubules elongate, thin, very graceful, about half as wide (or less) as thecae; dehiscence pores perfectly terminal.
            19. Filaments distinct; rachis to 0.5 cm long; calyx ca. 9 mm long; corolla 35–37 mm long _____ **Siphonandra magnifica**
            19. Filaments connate; rachis 2 -5 cm long; calyx 7–8 mm long; corolla 25–48 mm long.
                20. Corolla ca. 25 mm long _____ **Siphonandra elliptica**
                20. Corolla 43–48 mm long _____ **Siphonandra boliviana**
        18. Tubules about as wide as thecae, **or** if narrower then proportionally much shorter than thecae; dehiscence by lateral slits or elongate clefts.
            21. Thecae conspicuously papillate; tubules rigid, elongate- to short-conical; stamens often 1/3–1/2 as long as corolla.
                22. Leaves stiff coriaceous; pedicels 20 40(–55) mm long; calyx lobes prominent, 3–5 in number, often in a state of fusion, 1–3 mm long; corolla 18–35 mm long; stamens 9–15 mm long _____ **Psammisia guianensis**
                22. Leaves chartaceous to soft coriaeous; pedicels 10 14 mm long; calyx lobes lacking or 5, apiculate and less than 0.4 mm long; corolla 25 40 mm long; stamens 8–10 mm long _____ **Psammisia pauciflora**
            21. Thecae smooth to minutely papillate; tubules flexible, cylindric, elongate to short; stamens usually as long as corolla.

23. Calyx articulate with pedicel.
    24. Corolla elongate tubular,(7–)11–27 mm long, normally carnose or coriaceous, the lobes valvate; filamants short and inconspicuous with regard to anthers.
        25. Corolla 20 -27 mm long; staminal filaments distinct.
            26. Leaves truncate or subcuneate at base; calyx smooth, not papilose at base _____ **Thibaudia macrocalyx**
            26. Leaves attenuate at base; calyx strongly papillose at base _____ **Thibaudia axillaris**
        25. Corolla 7–13 mm long; staminal filaments connate.
            27. Leaves obtuse, rounded to subcordate at base; twigs, leaves, and inflorescences (including rachis, pedicels, calyx and sometimes corolla) densely white pilose _____ **Thibaudia densiflora**
            27. Leaves cuneate, attenuate or subattenuate at base; plant surfaces glabrous or essentially so.
                28. Leaf apex acute; calyx 5.5–6 mm long, the lobes deltate, ca. 1 mm long _____ **Thibaudia regularis**
                28. Leaf apex obtuse; calyx 2.5–3.5 mm long, the lobes apiculate, less than 1 mm long _____ **Thibaudia crenulata**
    24. Corolla urceolate to campanulate, 7–12 mm long, normally of thin texture and membranaceous, the lobes imbricate; filaments proportionally long with regards to anther length.
        29. Ovary with a single ovule in each of the 10 locules; fruit a drupe with 10 pyrenes _____ **Gaylussacia cardenasii**
        29. Ovary with few to numerous ovules in each of the 5(–10) locules; fruit a many-seeded berry.
            30. Leaves glabrous or lacking subfasciculate hairs beneath; corolla cylindric-urceolate, white to pinkish _____ **Vaccinium floribundum**
            30. Leaves with subfasciculate hairs beneath; corolla rotate-campanulate, green _____ **Vaccinium dependens**
23. Calyx continuous with pedicel, the pedicel not jointed at apex.
    31. Calyx conspicuously angled to 5-winged; corolla terete or angled.
        32. Calyx angled opposite the lobes _____ **Polyclita turbinata**
        32. Calyx angled to winged alternate with the lobes.
            33. Leaves linear, ca. 2 mm broad, 1-nerved _____ **Rusbya taxifolia**
            33. Leaves mostly ovate, greater than 1 cm broad, multi-nerved.
                34. Plants with pilose-hispid habit (including twigs, petioles, leaves beneath, racemes, pedicels, and calyx); corolla cylindric, terete throughout, 9–10 mm long, sparsely pilose distally _____ **Themistoclesia peruviana**
                34. Plants with glabrous habit (although leaves beneath with brownish fimbriae); corolla urceolate-turbinate, conspicuously swollen at base and narrowed at throat, bluntly 5-angled, 8–11 mm long, glabrous _____ **Themistoclesia unduavensis**
    31. Calyx terete; corolla terete.

35. Corollas usually large, carnose to coriaceous, (0.6–)1.5–5 cm or more long, if less than 1 cm then staminal tubules twice as long as thecae; staminal tubules 2–5 times longer than thecae; seeds with white embryos
    36. Corolla 0.6–0.8 cm long, white to pinkish _____ **Demosthenesia pearcei**
    36. Corolla 1.7–5 cm long, red.
        37. Corolla 2–3 cm long and 3–8 mm diam., slightly zygomorphic _____ **Demosthenesia mandonii**
        37. Corolla 3.5–5 cm long and 7–10 mm diam., actinomorphic _____ **Demosthenesia spectabilis**
35. Corollas small, thin membranaceous, up to 10 mm long, but if longer then filaments proportionally much longer than anthers; staminal tubules about equalling anthers; seeds with green embryos.
    38. Flowers usually in few- to many-flowered fascicles or racemes, rarely solitary; pedicels slender but not properly cernuous; filaments usually shorter than anthers.
        39. Inflorescence a fascicle of 3 6 flowers, the rachis none _____ **Diogenesia boliviana**
        39. Inflorescence a raceme of up to 18 flowers, the rachis 2.5–6 cm long _____ **Diogenesia racemosa**
    38. Flowers 1–2 per axil; pedicels usually relatively long and thin, filiform, cernuous, **or** rarely absent (i.e., flowers sessile); filaments usually longer than anthers.
        40. Flowers sessile _____ **Sphyrospermum sessiliflorum**
        40. Flowers conspicuously pedicellate.
            41. Leaves suborbicular to oblong-ovate, (0.7–) 0.9–1.5(–1.8) cm long, the apex rounded or obtuse; flowers usually extending well beyond the leaves; corolla 4 6 mm long; stamens 4 _____ **Sphyrospermum buxifolium**
            41. Leaves ovate to ovate-lanceolate, usually conspicuously longer than broad, (1–)2–3.5 (–5) cm long, the apex obtuse to acute, sometimes shortly and bluntly acuminate; flowers rarely extending beyond the leaves; corolla (4–)5–7(-9) mm long; stamens 4–5 or 8–10 _____ **Sphyrospermum cordifolium**

SPANISH KEYS

Notas sobre la utilización de las claves

Las siguientes claves se basan principalmente en ejemplares de herbario, aunque también en material vivo (*in situ* y de plantas de invernadero), material preservado en alcohol y fotografías tomadas en el campo y en invernaderos. Las medidas florales se tomaron del material de herbario en la antesis a menos que se diga lo contrario; los colores se tomaron del material vivo observados por el autor a menos que se diga lo contrario; si no se tiene un intervalo de

medidas, entonces las medidas conocidas se presentan precedidas por la abreviación "ca." (cerca); la longitud del limbo del cáliz incluye la medida de los lóbulos y la longitud de la antera incluye las tecas y los túbulos.

CLAVE PARA LAS ESPECIES BOLIVIANAS DE ERICACEAE CON OVARIO SÚPERO

1. Corola con pétalos separados; fruto una cápsula septicida _____ **Bejaria aestuans**
1. Corola con pétalos unidos; fruto una cápsula loculicida o una baya.
2. Estambres con filamentos geniculados; anteras sin aristas terminales y sin tejido blanco desintegrado en el lado abaxial _____ **Agarista boliviensis**
2. Estambres con filamentos rectos; anteras con aristas terminales y con tejido blanco desintegrado en el lado abaxial.
3. Fruto una baya, raras veces el cáliz se vuelve carnoso en la base pero nunca rodea la baya _____ **Pernettya prostrata**
3. Fruto una cápsula, rodeada por el cáliz carnoso y acrescente (cáliz raras veces no carnoso).
4. Flores solitarias en las axilas de las hojas normales (o ligeramente reducidas).
5. Arbusto de tallo grueso hasta 5 m de altura; corola campanulada, más ancha en el ápice, verde-amarillenta _____ **Gaultheria buxifolia** var. **secunda**
5. Subarbusto de tallo delgado hasta 0,4 (raras veces 1–2) m de altura; corola urceolada a estrechamente subglobosa, inflada en la base y muy contraida en la garganta, rosada a rosado-roja _____ **Gaultheria vaccinioides**
4. Flores en racimos axilares.
6. Superficie abaxial de la lámina y toda la inflorescencia lanado-tomentosas _____ **Gaultheria eriophylla** var. **mucronata**
6. Superficie abaxial de la lámina y la inflorescencia glabras o esparcida a densamente pubescentes pero nunca lanado-tomentosas.
7. Ramas jóvenes e inflorescencias conspicuamente estrigosas con pelos rectos, rígidos, adpresos, generalmente tan densos que ocultan las superficies; lámina en general densa y persistentemente rojizo-estrigosa en el envés.
8. Cáliz glabro; corola glabra a variablemente pubescente, nunca densamente estrigosa en todas partes; ovario glabro o muy débil y cortamente piloso en el ápice; inflorescencia congestionada (aglomerada) en la antesis con las flores ampliamente sobrepuestas _____ **Gaultheria glomerata**
8. Cáliz y corola densamente estrigoso-hirsuta con pelos ferrugíneos, subsetosos, raras veces glandulares; ovario densamente piloso con tricomas cortos, blancos o cinéreos; inflorescencia no congestionada en la antesis, las flores ampliamente espaciadas _____ **Gaultheria bracteata**
7. Ramas jóvenes e inflorescencias glabras o variadamente con pubescencia espaciada pero no apresado-estrigosa con pelos rectos, rígidos; lámina glabra o variadamente pubescente pero no estrigosa en el envés.
9. Subarbustos rizomatosos rastreros, 0,1–0,2 m de altura; lámina de la hoja generalmente obovada con el ápice redondeado _____ **Gaultheria hapalotricha**
9. Subarbustos a arbustos erectos, 0,1–8 m de altura; lámina de la hoja de forma variada pero raras veces obovada, el ápice generalmente agudo a acuminado.

10. Lámina de la hoja en general marcada y prominentemente reticulado-nervada en **ambas** caras, la base generalmente aguda a redondeada; inflorescencias agrupadas en la punta de las ramas y conspicuamente excediendo la longitud de las hojas; cáliz y corola eglandulares; corola blanca, pilosa por dentro _____ **Gaultheria reticulata**

10. Lámina de la hoja no conspicuamente reticulado-nervada en ambas superficies, la base generalmente redondeada y profundamente cordada; inflorescencias espaciadas a lo largo de las ramas, sin exceder la longitud de las hojas; cáliz y corola a menudo pubescente-glandulosos; corola roja, glabra por dentro _____ **Gaultheria erecta**

CLAVE PARA LAS ESPECIES BOLIVIANAS DE ERICACEAE CON OVARIO ÍNFERO

1. Estambres desiguales con filamentos o anteras, **o** filamentos y anteras alternamente desiguales en forma conspicua.
   2. Filamentos iguales y connados en toda su longitud; anteras con túbulos ensanchándose distalmente.
      3. Hojas elíptico-lanceoladas, 6–10 cm de largo, 1,5–3 cm de ancho, obtusas a redondeadas basalmente, 3-plinervias; inflorescencia densamente pilosa (excepto en la corola); pedicelos 16–21 mm de largo; corola ca. 11 mm de largo _____ **Satyria boliviana**
      3. Hojas elíptico-oblongas, 3–6 cm de largo, 1,2–1,8 cm de ancho, cuneadas a subatenuadas basalmente, pinnatinervias; inflorescencia glabra; pedicelos 6–12 mm de largo; corola ca. 6 mm de largo _____ **Satyria neglecta**
   2. Filamentos desiguales, libres o parcialmente connados; anteras con los lados paralelos, sin ensancharse distalmente.
      4. Anteras iguales; estambres 1/2–1/3 tan largos como la corola; brácteas florales raras veces grandes y vistosas pero si así, entonces deciduas tempranamente.
         5. Hojas pinnatinervias _____ **Orthaea pinnatinervia**
         5. Hojas plinervadas.
            6. Tallos, pecíolos, hojas, raquis, pedicelos y corola pilosos _____ **Orthaea rusbyi**
            6. Plantas esencialmente glabras.
               7. Corola 11–12 mm de largo _____ **Orthaea constans**
               7. Corola 15 33 mm de largo.
                  8. Filamentos estaminales libres.
                     9. Raquis 3–5 cm de largo; pedicelos 8–13 mm de largo _____ **Orthaea weberbaueri**
                     9. Raquis ca. 1 cm de largo; pedicelos ca. 7 mm de largo ___ **Orthaea ignea**
                  8. Filamentos estaminales connados.
                     10. Dehiscencia estaminal por poros terminales o subterminales ___ **Orthaea boliviensis**
                     10. Dehiscencia estaminal por suturas laterales _____ **Orthaea ferreyrae**
      4. Anteras desiguales; estambres tan largos como la corola o raras veces 1/2 2/3 de la longitud de ésta; brácteas florales generalmente grandes y vistosas, generalmente persistentes durante la antesis.
         11. Inflorescencia en panícula _____ **Cavendishia martii**
         11. Inflorescencia en racimo.
            12. Cáliz densamente lanoso, los pelos enredados persistentes; hojas con pelos suaves persistentes por el envés _____ **Cavendishia pubescens**

12. Cáliz glabro a piloso pero nunca lanoso y los pelos nunca enredados; hojas glabras a glabrescentes _____ **Cavendishia bracteata**

1. Estambres iguales con filamentos y anteras de igual longitud (raras veces las anteras alternamente desiguales en forma inconspicua).
13. Bractéolas localizadas en el ápice del pedicelo y rodeando el cáliz (y algunas veces la parte baja de la corola).
14. Hojas menos de 5 mm de ancho.
15. Corola campanulado-cilíndrica, 10–14 mm de largo, blanca, algunas veces teñida de rosado _____ **Disterigma pernettyoides**
15. Corola subcilíndrica a algo urceolada, 6–9 mm de largo, roja _____ **Disterigma empetrifolium**

14. Hojas más de 5 mm de ancho.
16. Corola 10–12 mm de largo, estrechamente cilíndrica, roja _____ **Disterigma pallidum**

16. Corola 4,5–7,5 mm de largo, subcilíndrica a ovado-urceolada, blanca a roja.
17. Flores 4-meras; corola subcilíndrica, raras veces pubérula por dentro; filamentos estaminales libres _____ **Disterigma alaternoides**
17. Flores generalmente 5-meras (algunas veces 4-meras); corola ovado-urceolada, conspicuamente pilosa por dentro; filamentos estaminales cohesionados en la base _____ **Disterigma ovatum**

13. Bractéolas localizadas muy por debajo del ápice del pedicelo **o** si apical entonces sin abrazar el cáliz.
18. Túbulos alargados, delgados, casi tan ancho como la mitad (o menos) de la teca; dehiscencia por poros perfectamente terminales.
19. Filamentos libres; raquis hasta 0,5 cm de largo; cáliz ca. 9 mm de largo; corola 35–37 mm de largo _____ **Siphonandra magnifica**
19. Filamentos connados; raquis 2–5 cm de largo; cáliz 7–8 mm de largo; corola 25–48 mm de largo.
20. Corola ca. 25 mm de largo _____ **Siphonandra elliptica**
20. Corola 43–48 mm de largo _____ **Siphonandra boliviana**

18. Túbulos casi tan anchos como la teca **o** si más delgados, entonces proporcionalmente mucho más cortos que la teca; dehiscencia por suturas laterales o hendiduras alargadas.
21. Teca conspicuamente papilosa; túbulos rígidos, alargados a cortamente cónicos; estambres a menudo 1/3–1/2 tan largos como la corola.
22. Hojas rígidamente coriáceas; pedicelos 20–40(–55) mm de largo; lóbulos del cáliz prominentes, 3–5, a menudo algo fusionados, 1–3 mm de largo; corola 18–35 mm de largo; estambres 9–15 mm de largo _____ **Psammisia guianensis**
22. Hojas cartáceas a suavemente coriáceas; pedicelo 10–14 mm de largo; lóbulos del cáliz ausentes ó 5, apiculados y menos de 0,4 mm de largo; corola 25–40 mm de largo; estambres 8–10 mm de largo _____ **Psammisia pauciflora**

21. Teca lisa a diminutamente papilosa; túbulos flexibles, cilíndricos, alargados a cortos; estambres generalmente tan largos como la corola.
23. Cáliz articulado con el pedicelo.
24. Corola alargada, tubular, (7–)11–27 mm de largo, normalmente carnosa o coriácea, los lóbulos valvados; filamentos cortos e inconspicuos con respecto a las anteras.

25. Corola 20 -27 mm de largo; filamentos estaminales libres.
    26. Hojas truncadas o subcuneadas en la base; cáliz liso, no papiloso en la base _____ **Thibaudia macrocalyx**
    26. Hojas atenuadas en la base; cáliz fuertemente papiloso en la base _____ **Thibaudia axillaris**
25. Corola 7–13 mm de largo; filamentos estaminales connados.
    27. Hojas obtusas, redondeadas a subcordadas en la base; ramas, hojas e inflorescencias (incluyendo raquis, pedicelos, cáliz y algunas veces la corola) densamente blanco-pilosas _____ **Thibaudia densiflora**
    27. Hojas cuneadas, atenuadas o subatenuadas en la base; superficies de la planta glabras o esencialmente glabras.
        28. Ápice de la hoja agudo; cáliz 5,5–6 mm de largo, los lóbulos deltados, ca. 1 mm de largo _____ **Thibaudia regularis**
        28. Ápice de la hoja obtuso; cáliz 2,5–3,5 mm de largo, los lóbulos apiculados, menos de 1 mm de largo _____ **Thibaudia crenulata**

24. Corola urceolada a campanulada, 7–12 mm de largo, normalmente de textura delgada y membranácea, los lóbulos imbricados; filamentos proporcionalmente largos con respecto a la longitud de las anteras.
    29. Ovario con 10 lóculos, un solo óvulo por lóculo; fruto una drupa con 10 pirenos _____ **Gaylussacia cardenasii**
    29. Ovario con 5(–10) lóculos, pocos a numerosos óvulos en cada lóculo; fruto una baya con muchas semillas.
        30. Hojas glabras o sin pelos subfasciculados en el envés; corola cilíndrico-urceolada, blanca a rosada _____ **Vaccinium floribundum**
        30. Hojas con pelos subfasciculados en el envés; corola rotado-campanulada, verde _____ **Vaccinium dependens**

23. Cáliz continuo con el pedicelo, no articulado.
    31. Cáliz conspicuamente angulado hasta 5-alado; corola terete o angulado.
        32. Cáliz angulado opuesto a los lóbulos _____ **Polyclita turbinata**
        32. Cáliz angulado a alado alterno con los lóbulos.
            33. Hojas lineares, ca. 2 mm de ancho, 1-nervias ___ **Rusbya taxifolia**
            33. Hojas principalmente ovadas, más de 1 cm de ancho, multinervias.
                34. Plantas con hábito híspido-piloso (incluyendo ramas, pecíolos, envés de las hojas, racimos, pedicelos y cáliz); corola cilíndrica, completamente terete, 9 10 mm de largo, espaciadamente pilosa en el parte distal _____ **Themistoclesia peruviana**
                34. Plantas con hábito glabro (aunque el envés de las hojas con fimbrias de color castaño); corola urceolado turbinada, conspicuamente hinchada en la base y estrecha en la garganta, ampliamente 5-angulada, 8–11 mm de largo, glabra _____ **Themistoclesia unduavensis**

31. Cáliz terete; corola terete.
    35. Corola generalmente grande, carnosa a coriácea, (0,6–)1,5–5 cm o más de largo, si menos de 1 cm entonces los túbulos estaminales dos veces tan largos como las tecas; túbulos estaminales 2–5 veces más grandes que las tecas; semillas con embriones blancos.
        36. Corola 0,6–0,8 cm de largo, blanca a rosada ___ **Demosthenesia pearcei**
        36. Corola 1,7–5 cm de largo, roja.
            37. Corola 2–3 cm de largo y 3–8 mm en diám., ligeramente zigomorfa _____ **Demosthenesia mandonii**
            37. Corola 3,5–5 cm de largo y 7–10 mm en diám., actinomorfa _____ **Demosthenesia spectabilis**
    35. Corola pequeña, delgada, membranácea, hasta 10 mm de largo, pero si es más larga entonces los filamentos proporcionalmente mucho más largos que las anteras; túbulos estaminales casi igualando las anteras; semillas con embriones verdes.
        38. Flores generalmente en fascículos o racimos de pocas a muchas flores, raras veces solitarias; pedicelos delgados pero no propiamente péndulos; filamentos generalmente más cortos que las anteras.
            39. Inflorescencia en fascículos de 3–6 flores, sin raquis _____ **Diogenesia boliviana**
            39. Inflorescencia en racimos de hasta 18 flores, el raquis 2,5–6 cm de largo _____ **Diogenesia racemosa**
        38. Flores 1–2 por axila; pedicelos en general relativamente largos y delgados, filiformes, péndulos **o** raras veces ausentes (flores sésiles); filamentos generalmente más largos que las anteras.
            40. Flores sésiles _____ **Sphyrospermum sessiliflorum**
            40. Flores conspicuamente pediceladas.
                41. Hojas suborbiculares a oblongo-ovadas, (0,7–)0,9–1,5(–1,8) cm de largo, el ápice redondeado u obtuso; flores generalmente extendiéndose mucho más allá de las hojas; corola 4–6 mm delargo; estambres 4 ____ **Sphyrospermum buxifolium**
                41. Hojas ovadas a ovado-lanceoladas, en general conspicuamente más largas que anchas, (1–)2–3,5(–5) cm de largo, el ápice obtuso a agudo, algunas veces corta y llanamente acuminado; flores raras veces extendiéndose más allá de las hojas; corola (4–)5–7(–9) mm de largo; estambres 4–5 u 8–10 ____ **Sphyrospermum cordifolium**

NEW SPECIES

Siphonandra boliviana Luteyn, sp. nov. (**Fig. 1**). TYPE: BOLIVIA. DEPTO. LA PAZ. Prov. Bautista Saavedra: Charazani, W of Chullina, 3400 m, 1 Aug 1994 (fl), *B. Herzog H200* (HOLOTYPE: NY; ISOTYPES: LZ, s.n.).

A *S. magnifica* staminum filamentis connatis nec distinctis, rhachidibus 2–5 nec 0.5 cm longis, et ab *S. elliptica* corollis 45–47 nec ca. 25 mm longis differt.

Shrub (size unknown); mature branches terete, glabrous, the bark exfoliating in thin strips; twigs subterete, sometimes shallowly angled or ribbed, short-pilose with white hairs; buds axillary, the scales 2, valvate, ca. 2 mm long, short-pilose. *Leaves* alternate, coriaceous, elliptic to oblanceolate, 2.5–5.5 cm long, 1–1.8 cm broad, basally cuneate, apically broadly acute to nearly obtuse, marginally entire, essentially glabrous above or sparsely short-pilose proximally along midrib, sparsely pilose beneath especially along midrib, also provided with reddish-brown, basally swollen, glandular fimbriae beneath; pinnately nerved with 4–6 secondary veins anastomosing near margin, the midrib and secondary veins impressed above and raised beneath, the reticulate veins plane to slightly impressed above but inconspicuously raised beneath; petiole rugose, subterete, broadly flattened above, 4–5 mm long. *Inflorescence* axillary, racemose, ca. 20-flowered, apparently nodding; rachis subterete, striate to angled, densely short-pilose with white hairs, at least 5 cm long (still in bud, apparantly still elongating); floral bracts ovate, acuminate, 3–4 mm long, densely short-pilose; pedicels subterete, striate to angled, densely short-pilose as rachis, 11–13 mm long; bracteoles located in proximal 1/3 pedicel, similar to floral bracts, 2–3 mm long. *Flowers*: calyx articulate with pedicel, 7–8 mm long, densely short-pilose as rachis; hypanthium cylindric, ribbed, 4–5 mm long, rounded at base; limb spreading-campanulate, 3.8–4.5 mm long; lobes 5, deltate, acute, 1.5–2 mm long; sinuses obtuse; corolla of 5 fused petals, long-cylindric, 43–48 mm long, 6–7 mm diam., short-pilose throughout, with white hairs, the lobes 5, deltate, acute, ca. 2 mm long; stamens 10, equal, ca. 32 mm long; filaments connate, glabrous, ca. 7 mm long; anthers ca. 28 mm long; thecae granular, ca. 6 mm long, incurved at base; tubules thin, delicate, about half as wide as thecae, ca. 22 mm long, dehiscing by perfectly terminal, flaring pores; ovary 5-locular; style about equaling corolla. *Berry* not seen.

Distribution.—Endemic to Bolivia and known only from the type collection, which was made in a *Weinmannia* forest.

Etymology.—The species is named for the country Bolivia to which it is endemic.

Siphonandra is a small, distinctive, high-elevation genus of three species: *S. elliptica* which is common and ranges from south-central Peru to northern Bolivia, *S. magnifica* which is endemic to Bolivia and is herewith maintained despite the fact that the type and only specimen was destroyed during World War II, and the new species herein described *S. boliviana*, for which only the type collection is known. With only one extant collection of the latter two species, it is difficult to assess the relationships between any of the three species in this genus. Nevertheless, *S. boliviana* is easily distinguished morphologically from the other two species by the characters mentioned in the key and diagnosis.

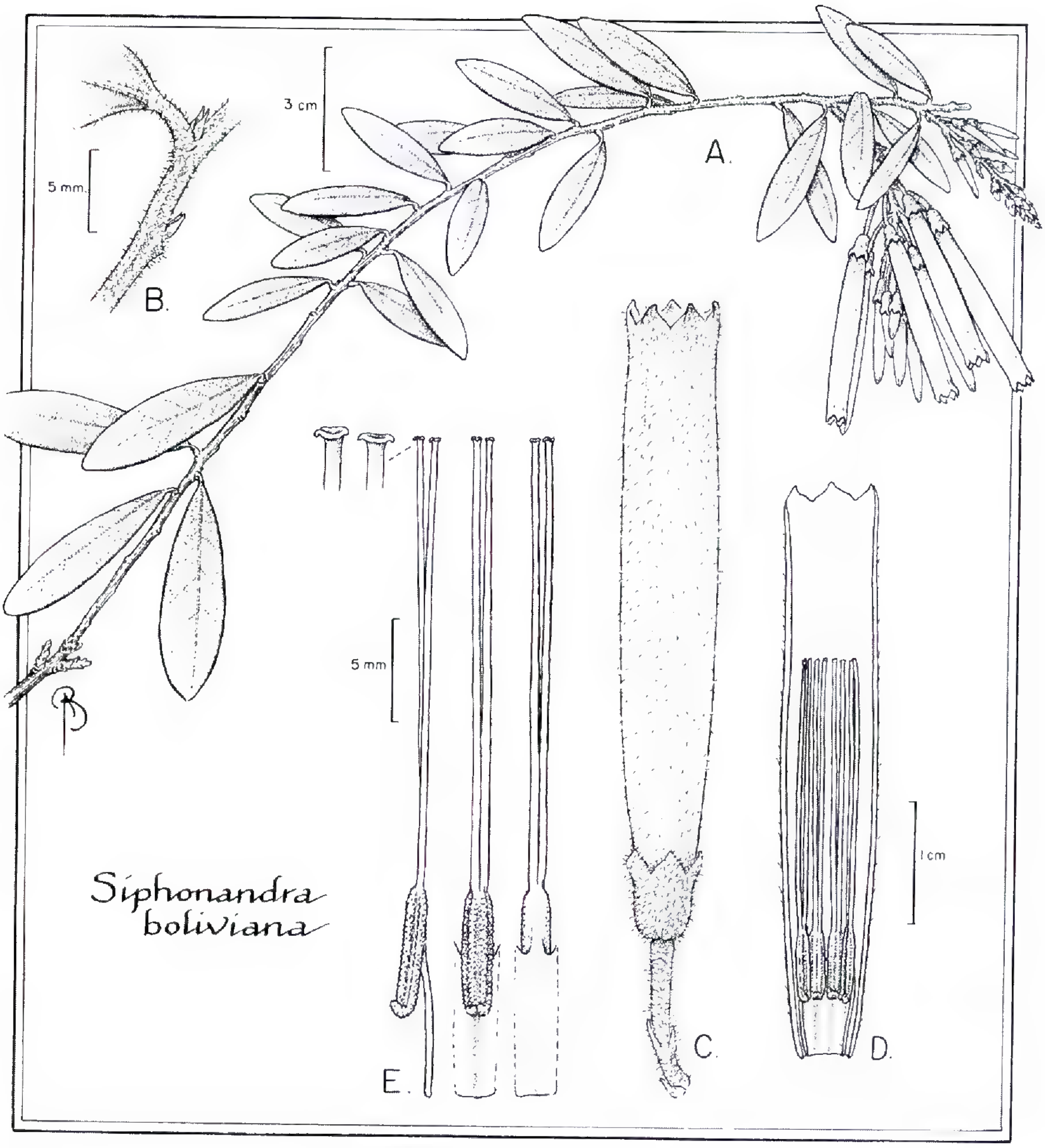


Fig. 1. *Siphonandra boliviana* Luteyn. A. Habit. B. Portion of stem showing pubescence. C. Flower showing floral bract, pedicel, bracteoles, calyx and corolla. D. Longitudinal section of corolla showing position of stamens. E. Stamens showing side, front, and back views with details of terminal dehiscence pores. (From type collection).

Themistoclesia unduavensis Luteyn, sp. nov. (**Fig. 2**). TYPE: BOLIVIA. DEPTO. LA PAZ. Prov. Nor Yungas: trail to Río Coscapa, ca. 2.5 km E of Unduavi, along new rd to Coroico, and ca. 6 km W of Cotapata, ca. 16° 17'S, 67° 53'W, 3200–3350 m, 19 Mar 2000 (fl), *J.L. Luteyn, E. Ann Powell & S. Beck 15471* (HOLOTYPE: NY; ISOTYPES: AAU, CAS, F, K, LPB, MO, TEX, plus 6 others to be distributed by LPB).

A *T. peruviana* habitu glabro nec piloso-hispido, corolla ventricosa et angulosa nec cylindrica et teretia, et glabra nec pilosa distaliter differt.

Rhizomatous, terrestrial or epiphytic *subshrubs*, to 30 cm tall; mature stems terete, striate, glabrous, the bark cracking longitudinally but not exfoliating;

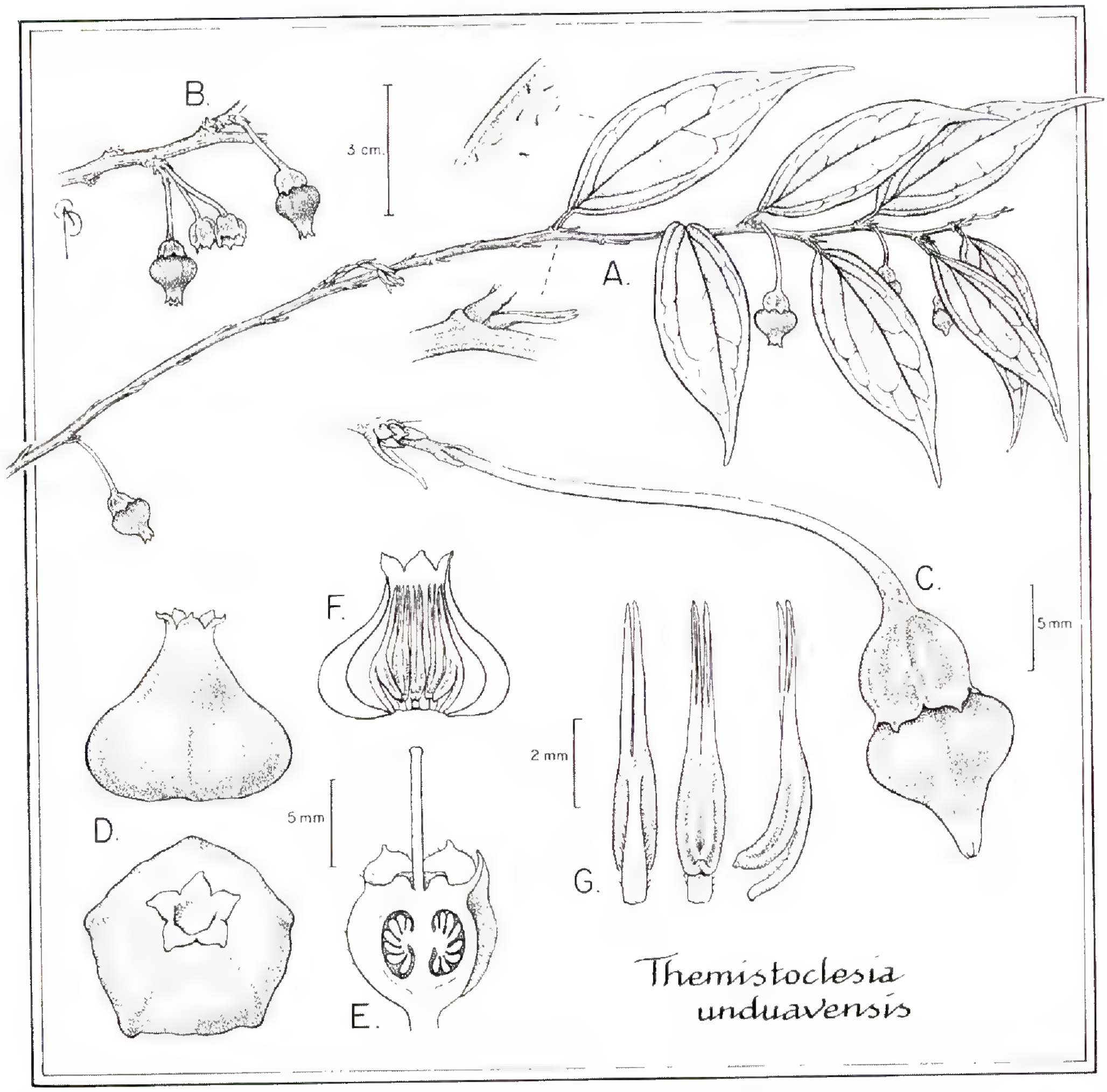


Fig. 2. *Themistoclesia unduavensis* Luteyn. A. Habit with details of leaf undersurface and axillary bud-scales. B. Portion of stem showing inflorescences. C. Inflorescence showing twig, floral bracts, pedicel, bracteoles, calyx, and corolla. D. Corolla showing side and top views. E. Longitudinal section of calyx. F. Longitudinal section of corolla showing position of stamens. G. Stamens showing back, front, and side views. (A from *Solomon 18195*; B-G from type collection).

twigs subterete, flattened to broadly and obtusely ribbed, weakly striate, glabrous; buds axillary, the scales 2, valvate, ovate, acuminate to acicular, 4–5 mm long. *Leaves* alternate, coriaceous, slightly bullate, clustered near apex, ovate to elliptic-ovate, 4.4–9 cm long, 1.4–4.5 cm broad, basally rounded to obtuse, apically long-acuminate, marginally entire, glabrous on both surfaces but provided with brownish, glandular fimbriae beneath; 3–5-plinerved with inner nerves arising 7–11 mm above base, midrib, lateral nerves, and reticulate veinlets impressed above and raised beneath; petioles rugose, subterete, broadly flattened above, 3.5–5 mm long, glabrate. *Inflorescences* axillary but usually from older, leafless nodes, flowers 1–2(–3) per node, when 2–3 then with very short

rachis; rachis (when present) subterete, 1–4 mm long, glabrous, obscure; floral bract ovate, acute, somewhat cucullate, ca. 2 mm long, marginally glandular-fimbriate, glabrous; pedicels slender, subterete, striate, sharply angled distally, 14–18 mm long, glabrous; bracteoles nearly basal, ovate, acuminate ca. 3 mm long, glabrous but marginally glandular-fimbriate. *Flowers*: calyx continuous with pedicel, 6–8.5 mm long, essentially glabrous; hypanthium obpyramidal, strongly 5-winged, 3.5–5 mm long, sparsely short-pilose along proximal portions of wings; limb spreading, ca. 3–3.5 mm long; lobes 5, broadly ovate, sharply and shortly acuminate, ca. 2–2.8 mm long, sparsely short-pilose along margins; sinuses acute; corolla of 5 fused petals, carnose, urceolate-turbinate, broadly swollen basally, broadly and bluntly 5-angled, 8–11 mm long, 7–12 mm diam. at base, glabrous, reddish-orange, the lobes 5, reflexed, deltate, acute, ca. 1.5 mm long, green in bud but becoming light green to white at anthesis; stamens 10, equal, nearly as long as corolla, ca. 8 mm long; filaments distinct, sparsely short-pilose, ca. 2.5–3 mm long; anthers ca. 7–7.5 mm long; thecae smooth, incurved at base, ca. 3.5 mm long; tubules distinct to base, ca. 3.5–4 mm long; ovary 5-locular; style about equaling corolla. Berry not seen.

Distribution.—Endemic to Bolivia and known only from the province of Nor Yungas, between Unduavi and Cotapata, at ca. 3000–3500 m. The plants are found in the wet, moss-covered, cloud forest associated with *Clusia*, *Weinmannia*, *Hedyosmum*, *Brunellia*, *Miconia*, and *Desfontainea*.

Etymology.—The species is named for the small village of Unduavi, close to the locality from which all collections have been made.

Themistoclesia is a neotropical genus of ca. 25 species, ranging from Costa Rica and Panama through the Andes of South America from Venezuela into northern Bolivia. *Themistoclesia unduavensis* may be distinguished by its rhizomatous, subshrub habit, somewhat bullate leaves, 1–3-flowered, axillary and often ramiflorous inflorescences, carnose corollas that are bluntly 5-angled and basally swollen, and reddish-orange corollas with green to white lobes. Individually each of these characters is either absent or uncommon amongst the other species in the genus, and the combination of characters effectively isolate this species from all others.

Additional collections examined: **BOLIVIA. La Paz. Nor Yungas:** between Unduavi and Cotapata, ascending Páramo Yunqueño, 3200 m, 8 Apr 1996 (fl), *Beck 22680* (NY, LBP); Unduavi, 3000 m, Jul 1965 (fl), *Braun 37* (US); 4 km E of Unduavi Nuevo, mule trail of Rusby, 3300 m, 20 Mar 1988 (fl), *Grifo & Solomon 1005* (BH, NY); trail to Río Coscapa, ca. 3 km E of Unduavi along new rd, 5.6 km W of Cotapata, 3300-3500 m, 5 May 1990 (fl), *Luteyn & Dorr 13476* (NY, LPB, plus 5 to be distributed); 1.4 km E of Cotapata, 3200 m, 20 Mar 1988 (fl), *Solomon 18195* (MO, NY).

APPENDIX

List of all species of Ericaceae attributed to Bolivia, including current status of names given by Foster (1958). [Key: names appearing in *italics* are currently

synonyms; names appearing in Roman are currently accepted; **!** = new species; **BO** = species endemic to Bolivia (or nearly so); * = species endemic to northern Bolivia and adjacent central to southern Peru; ** = species not found in Bolivia; **CULT** = introduced ornamental species.]

Agarista boliviensis (Sleumer) Judd **BO** (but see Judd and Hermann 1990)

Befaria = Bejaria

Befaria boliviensis B.Fedtsch. & Basilevsk. = Bejaria aestuans

Befaria denticulata Remy = Bejaria aestuans

Befaria glauca Bonpl. = Bejaria aestuans

Befaria glauca var. *coarctata* (Bonpl.) Mansf. & Sleumer = Bejaria aestuans

Befaria glauca var. *glandulosa* Mansf. & Sleumer = Bejaria aestuans

Befaria glauca var. setosa Mansf. & Sleumer = Bejaria aestuans

Befaria glauca var. *tomentella* Mansf. & Slemuer = Bejaria aestuans

Befaria hispida Poeppig & Endl. = Bejaria aestuans

Befaria parvifolia Rusby = Bejaria aestuans

Bejaria aestuans L.

Cavendishia acuminata (Hook.) Hemsl. = Cavendishia bracteata

Cavendishia beckmanniana Hoerold = Cavendishia bracteata

Cavendishia bracteata (Ruiz & Pav. ex J.St. Hil.) Hoerold

Cavendishia martii (Meissn.) A.C.Sm. *

Cavendishia paniculata Rusby = Cavendishia martii

Cavendishia pubescens (Kunth) Hemsl.

Cavendishia pubescens var. *boliviensis* Hoerold = Cavendishia pubescens

Cavendishia sillarensis Herzog = Cavendishia bracteata

Cavendishia strobilifera (Kunth) Hoer. = Cavendishia bracteata

Ceratostema hookeri Britton = Siphonandra elliptica

Ceratostema serratum Britton Thibaudia macrocalyx

Chupalon viridiflorum Kuntze = Cavendishia martii

Clethra spp. = Clethraceae

Demosthenesia fabulosa (Slemuer) A.C.Sm. = ? (type and only specimen destroyed during World War II; protologue insufficient for generic determination)

Demosthenesia graebneriana (Hoerold) A.C.Sm. = D. mandonii

Demosthenesia mandonii (Britton) A.C.Sm. *

Demosthenesia pearcei (Britton) A.C.Sm. **BO**

Demosthenesia spectabilis (Rusby) A.C.Sm. *

Diogenesia boliviana (Britton) Sleumer **BO**

Diogenesia racemosa (Herzog) Sleumer **BO**

Disterigma alaternoides (Kunth) Nied.

Disterigma alaternoides var. *parvifolium* (Benth.) A.C.Sm. = Disterigma alaternoides

Disterigma empetrifolium (Kunth) Drude

Disterigma ovatum (Rusby) S.F.Blake *

Disterigma pallidum A.C.Sm. **BO**

Disterigma pernettyoides (Griseb. ex Wedd.) Nied. *

Eleutherostemon bolivianum (Britton) Herzog = Diogenesia boliviana

Eleutherostemon racemosum Herzog = Diogenesia racemosa

Gaultheria anastomosans (L.f.) Kunth –not found in Bolivia, only in Colombia and Venezuela

Gaultheria barosmoides Rusby = Gaultheria vaccinioides

Gaultheria brachybotrys DC. = Gaultheria glomerata

Gaultheria bracteata (Cav.) G.Don *

Gaultheria buxifolia Willd. var. secunda (Remy) Luteyn *

Gaultheria conferta Benth. = Gaultheria anastomosans

Gaultheria cordifolia Kunth = Gaultheria erecta

Gaultheria erecta Vent.

Gaultheria eriophylla (Pers.) Sleumer ex Burtt var. mucronata (Remy) Luteyn *

Gaultheria formosa Remy = Gaultheria erecta

Gaultheria glabra DC. = Gaultheria reticulata Kunth

Gaultheria glomerata (Cav.) Sleumer

Gaultheria hapalotricha A.C.Sm.

Gaultheria mucronata Remy = Gaultheria eriophylla var. mucronata
Gaultheria odorata Bredemeyer ex Willd. = Gaultheria erecta
Gaultheria pichinchensis Benth. – Gaultheria glomerata
Gaultheria remyana A.C.Sm. = Gaultheria eriophylla var. mucronata
Gaultheria reticulata Kunth
Gaultheria rufescens DC. = Gaultheria bracteata
Gaultheria saxicola Wedd. = Gaultheria vaccinioides
Gaultheria secunda Remy = Gaultheria buxifolia var. secunda
Gaultheria serrulata Herzog = ? Gaultheria vaccinioides x G. erecta (see Luteyn 1995)
Gaultheria tetriches Rusby – Gaultheria erecta
Gaultheria tomentosa Kunth **
Gaultheria vaccinioides Wedd. *

Gaylussacia cardenasii A.C.Sm. **BO**
Gaylussacia pseudogaultheria Cham. & Schlechtd. = not found in Bolivia, only in Brazil

Hornemannia boliviensis Kuntze = Thibaudia boliviensis

Leucothoë boliviensis Sleumer = Agarista boliviensis

Orthaea boliviensis B.Fedtsch. & Basilevsk. **BO**
Orthaea constans A.C.Sm. **BO**
Orthaea ferreyrae A.C.Sm. *
Orthaea ignea Sleumer *
Orthaea pinnatinervia Mansf. *
Orthaea rusbyi Luteyn **BO**
Orthaea weberbaueri Hoerold *

Pernettya densa Rusby = Pernettya prostrata
Pernettya phyllyraefolia (Pers.) DC. =not found in Bolivia, only Argentina and Chile
Pernettya prostrata (Cav.) DC.
Pernettya prostrata var. *pentlandii* (DC.) Sleumer = Pernettya prostrata
Pernettya prostrata var. *purpurea* (D.Don ex G.Don) Sleumer = Pernettya prostrata
Pernettya schizostigma Rusby = Pernettya prostrata

Polyclita turbinata (Kuntze) A.C.Sm. **BO**

Psammisia elliptica (Rusby) A.C.Sm. = Psammisia pauciflora
Psammisia guianensis Klotzsch
Psammisia pauciflora Griseb. ex A.C.Sm.

Rhododendron simsii Planchon **CULT**

Rusbya boliviana Britton = Diogenesia boliviana
Rusbya pearcei Britton = Demosthenesia pearcei
Rusbya taxifolia Britton **BO**

Satyria boliviana Luteyn **BO**
Satyria neglecta A.C.Sm. **BO**

Siphonandra boliviana Luteyn **! BO**
Siphonandra elliptica (Ruiz & Pav. ex G.Don) Klotzsch *
Siphonandra magnifica Sleumer = ? (type and only specimen destroyed during World War II, but protologue sufficient for determination) **BO**
Siphonandra pilosa A.C.Sm. = Siphonandra elliptica

Sophoclesia robusta Rusby = Sphyrospermum cordifolium

Sphyrospermum buxifolium Poeppig & Endl.
Sphyrospermum cordifolium Benth.
Sphyrospermum sessiliflorum Luteyn **BO**

Themistoclesia peruviana A.C.Sm. *
Themistoclesia unduavensis Luteyn **! BO**

Thibaudia axillaris Rusby **BO**
Thibaudia boliviensis (Kuntze) Hoerold = Thibaudia crenulata
Thibaudia crenulata Remy *
Thibaudia densiflora (Herzog) A.C.Sm. **BO**
Thibaudia macrocalyx Remy **BO**
Thibaudia oblongifolia Remy = Cavendishia pubescens
Thibaudia regularis A.C.Sm. *

Vacciniopsis ovata Rusby = Disterigma ovatum
Vacciniopsis tetramera Rusby = Disterigma alaternoides

Vaccinium dependens (G.Don) Sleumer *
Vaccinium didymanthum Dunal =not in Bolivia, only Peru
Vaccinium empetrifolium Kunth = Disterigma empetrifolium
Vaccinium epacridifolium Benth. = Disterigma empetrifolium
Vaccinium floribundum Kunth
Vaccinium floribundum var. *ramosissimum* (Dunal) Sleumer = Vaccinium floribundum
Vaccinium floribundum var. *tatei* (Rusby) Sleumer = Vaccinium floribundum
Vaccinium marginatum Dunal = Vaccinium floribundum

Vaccinium penaeoides Kunth = Disterigma empetrifolium

Vaccinium polystachyum Benth. = Vaccinium floribundum

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TWO NEW SPECIES OF *FESTUCA* FROM SOUTH AMERICA (POACEAE: LOLIINAE: SECT. SUBULATAE)

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ABSTRACT

Two new species, *Festuca cuzcoensis* Stančík & P.M. Peterson and *F. tovarensis* Stančík & P.M. Peterson, from the Andes of Bolivia and Peru are described and illustrated. The two new species appear to be closely related to *Festuca flacca* Hack. ex E.B. Alexeev from Ecuador. A key to the South American species of *Festuca* sect. *Subulatae* is given.

RESUMEN

Se describen e ilustran dos especias nuevas de *Festuca* de los Andes de Bolivia y Perú: *F. cuzcoensis* Stančík & P.M. Peterson y *F. tovarensis* Stančík & P.M. Peterson. Las nuevas especies se consideran estrechamente relacionadas con la especies *F. flacca* Hack. ex E.B. Alexeev de Ecuador. Además se presenta una clave para la determinación de las especies de *Festuca* sect. *Subulatae* en Suramérica.

While making determinations of South American material in the United States National Herbarium the senior author recognized several specimens with unique features. The two new species discussed here appear to be members of *Festuca* subg. *Subulatae* (Tzvelev) E.B. Alexeev sect. *Subulatae*. The position of sect. *Subulatae* in subg. *Subulatae* is clear, however, the relationships with other sections in this subgenus are unresolved. Alexeev (1980, 1982, 1986) recognized three sections in subg. *Subulatae*: sect. *Subulatae*, sect. *Elmera* E.B. Alexeev, and sect. *Glabricarpae* E.B. Alexeev. Alexeev (1986) and Clayton and Renvoize (1986) also recognized two other subgenera in these flat-bladed South American species of *Festuca*: subg. *Subuliflorae* E.B. Alexeev and subg. *Obtusae* E.B. Alexeev. Aiken's et al. (1997) treatment included species of subg. *Subuliflorae* and subg. *Obtusae*, sensu Alexeev, in subg. *Subulatae* sect. *Obtusae*, and moved a single species from sect. *Elmera*, sensu Alexeev, to sect. *Subulatae*. In addition, Lu (1992) described sect. *Longiglumes* S.L. Lu to include some Chinese species within subg. *Subulatae*. Clearly, there are considerable differences of opinion among prominent agrostologists as to possible taxonomic relationships among these *Festuca* species.

Section *Subulatae* consists of about 25 species from North and South America, Asia, and Africa (Aiken et al. 1997; Alexeev 1977, 1980, 1988; Lu 1992; Stančík ined.). Individuals of *Festuca* sect. *Subulate* are typically loosely tufted

with extravaginal innovations lacking cataphylls, with flat blades without well-developed ribs, and have relatively large, open panicles with numerous branches. In this section the spikelets are typically lanceolate with two short, entire, and narrow glumes that are membranous to coriaceous/membranous. The coriaceous/membranous lemmas are lanceolate, entire, and usually long-awned or rarely awnless. Anthers are short (1–2 mm long) and the ovary hairy, rarely glabrous. The two new species discussed here clearly are members of subfamily Pooideae, tribe Poeae, and subtribe Loliinae (Soreng et al. 2001). With the addition of these two new species in South America, *Festuca* sect. *Subulatae* consists of the following eight species: *F. cochabambana* E.B. Alexeev, *F. coromotensis* Briceño, *F. cuzcoensis*, *F. flacca* Hack. ex E.B. Alexeev, *F. parodiana* (St.-Yves) Nicora, *F. sodiroana* Hack. ex E.B. Alexeev, *F. tovarensis*, and *F. ulochaeta* Nees ex Steud.

Festuca cuzcoensis Stančík & P.M. Peterson, sp. nov. (**Fig. 1**). TYPE: PERU. DEPARTAMENTO CUZCO. Provincia Urubamba: above Ollantaytambo, in shade, high up ravine, 3600 m, 5 Dec 1923, *A.S. Hitchcock 22532* (HOLOTYPE: US-1164548!).

Festuca ulochaeta auct. non Nees ex Steud: Hitchcock 1927, 321 p.p. Macbride 1936, 123 p.p. Tovar 1993, 90 p.p.

Haec species a *Festuca ulochaeta* Nees ex Steud. et *F. tovarensis* Stančík & P.M. Peterson culmis multinodis (6–12 non 2–4) et aristae brevi [3–4 (–5) non 5–12 mm] differt. A *Festuca ulochaeta* Nees ex Steud. et *F. cochabambana* E.B. Alexeev ligula folii 2–3 (non 0.2–2) mm longa distinguitur.

Perennial, loosely tufted. Culms 80–110 cm tall, erect, glabrous, with 6–12 nodes in basal half, the internodes short. Sheaths membranous, brown, more or less pubescent, margins free; innovations extravaginal; auricles absent. Ligules 2–3 mm long, membranous, acuminate, dentate. Blades 12–15 cm long, 3–9 mm wide, flat, green, scabrous on ribs of abaxial surface. Panicles 20–25 cm long, 5–10 cm wide, open; branches pendant, scabrous. Spikelets 8–10 mm long; florets 3–4 (perfect); rachilla 1.2–1.4 mm long, puberulent. Glumes narrowly lanceolate, coriaceous, purplish, scabrous, apex acute; lower glume (2–)2.5–4.5 mm long, 1-veined; upper glume 4–6 mm long, inconspicuously 3-veined. Lemma 7–8.5 mm long, lanceolate, chartaceous to membranous, 3- or 5-veined, purplish-green; apex scabrous, entire; awn 3–4(–5) mm long, scabrous, straight. Palea almost as long as lemma, 2-keeled, the keels finely scabrous, deeply 2-dentate. Lodicules oblong, 2-dentate. Stamens 3; anthers (1.2–)1.5–2 mm long. Ovary apex with a few hairs. Caryopses lanceolate.

Distribution and habitat.—This species was collected in Andean forest zone of Peru and northeastern Bolivia between 3200–3850 m.

Etymology.—The specific epithet refers to the type locality region, i.e., Department Cuzco in southern Peru.

Additional specimens examined: **BOLIVIA. Departamento La Paz:** Unduavi, in Walden, 3300 m, 12 Feb 1907, *Buchtien 6415* (US). PERU. **Departamento Ancash. Prov. Yungay:** Huascarán National Park,

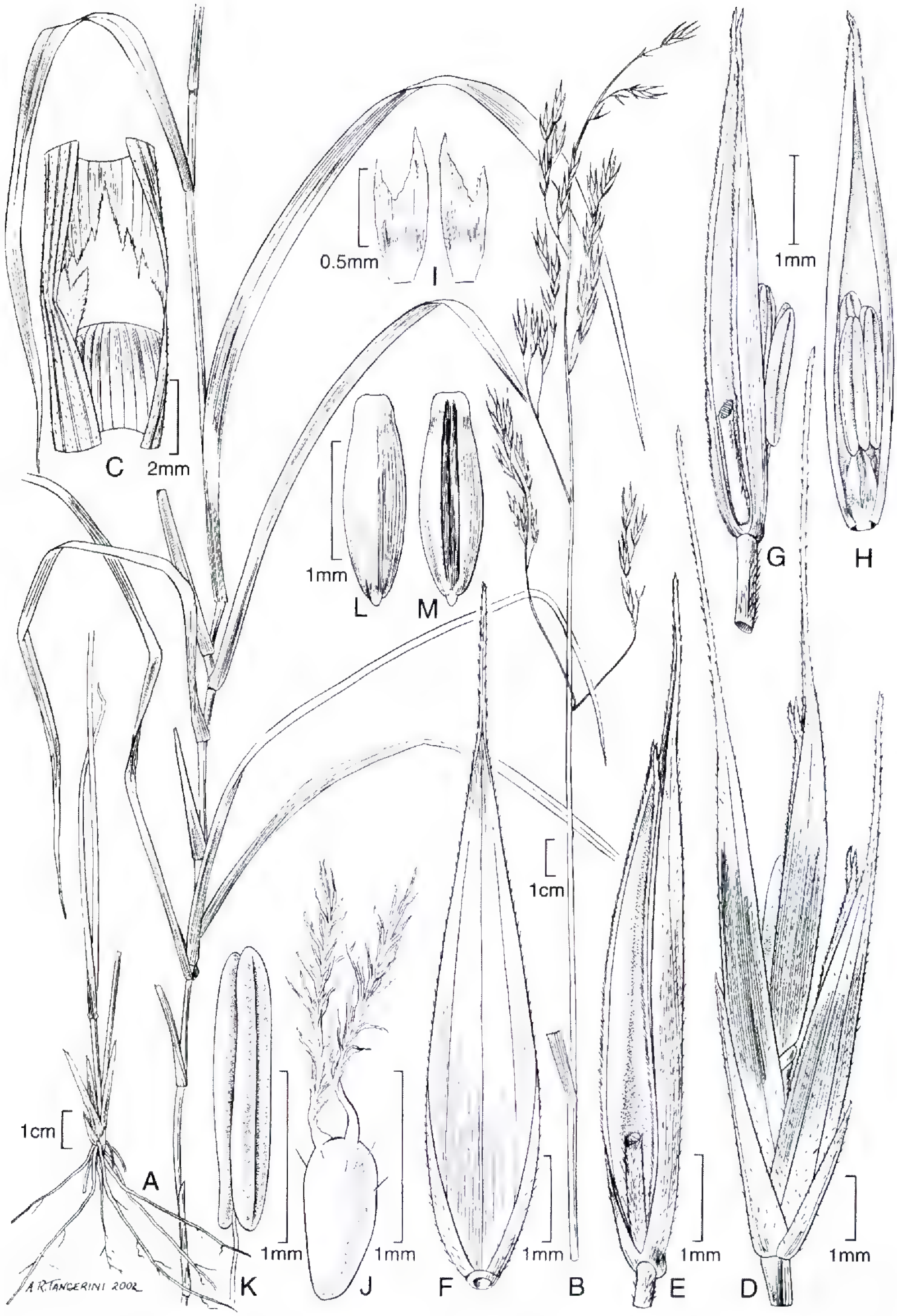


FIG. 1. *Festuca cuzcoensis* (*Hitchcock 2253*). A. Habit. B. Inflorescence. C. Sheath, ligule, and portion of a blade. D. Spikelet. E. Floret. F. Lemma, ventral view. G. Palea with stamens. H. Palea, with stamens and lodicules. I. Lodicules. J. Pistil. K. Stamen. L. Caryopsis, dorsal view. M. Caryopsis, ventral view.

Llanganuco sector, between Chinancocha and Pucayacu (77° 39' W-09° 05' S), 3700-3850 m, 7 May 1985, *Smith 10517* (USM); *Smith 10551* (USM); *Smith 10561* (USM). **Prov. Huari:** Huascarán National Park, Quebrada Pachachaca, a lateral valley of Quebrada Rurichinchay (77° 16' W-9° 23' S), 3840–3870 m, 13 Jun 1986, *Smith et al. 12632* (USM). **Departamento Cuzco. Prov. Calca:** 7 km SE of Lares on road towards Pampa Corral and Calca (13° 08' 49.9" S-72° 00' 34.2" W), 3620 m, 17 Mar 2002, *Peterson & Refulio-Rodriguez 16582* (PRC, US, USM). **Departamento Huancavelica. Prov. Tayacaja:** Near Salcabamba, 3200 m, 13 Apr 1962, *Tovar 3612* (USM).

Festuca tovarensis Stančík & P.M. Peterson, sp. nov. (**Fig. 2**). TYPE: PERU. Departamento Huancavelica, Provincia Tayacaja: Chuspi-Hda. Tocas, entre Colchabamba y Paucarbamba, monte bajo, 2800 m, 22 Apr 1954, *O. Tovar 2057* (HOLOTYPE: US-2181286!; ISOTYPE: USM!).

Festuca ulochaeta auct. non Nees ex Steud: Tovar 1993, 90 p.p. Brako L. et al. 1993, 950.

Haec species a *Festuca ulochaeta* Nees ex Steud. lemmate breviore (5.5–6.5 non 6–9 mm), arista 5 7 (non 7 15) mm longa et recta (non flexuosa) differt. A *Festuca flacca* Hack. ex E.B. Alexeev ligula folii 1–2 (non 2–4.5) mm longa, truncata et ciliata (non lacerata), glumis superioribus 3.5–5 (non 2.3–3.5) mm et antheris 1.5–1.6 (non 0.9–1.2) mm distinguitur.

Loosely tufted perennials. Culms 70–90 cm tall, erect, glabrous, with 2–4 nodes in basal half. Sheaths membranous, brown, margins free; innovations extravaginal; auricles absent. Ligules 1–2 mm long, membranous, truncate, margins ciliate. Blades 8–15 cm long, 1.5–4.5 mm wide, linear, flat, green, scabrous with ribs on abaxial surface. Panicles 15–20 cm long, 7–10 cm wide, open; branches pendant, scabrous. Spikelets 7.5–9.5 mm long; florets 3 (perfect); rachilla 1.1–1.4 mm long, puberulent. Glumes narrowly lanceolate, coriaceous, purplish, glabrous, apex acute (sometimes scabrous); lower glume 1.5–1.8 mm long, 1-veined; upper glume 3.5–4.5(–5) mm long, 1–3 veined. Lemma 5.5–6.5 mm long, lanceolate, chartaceous to membranous, 3-veined, purplish-green, scabrous; apex entire; awn 5–7 mm long, terminal, scabrous, straight. Palea as long as lemma, 2-keeled, the keels scabrous; apex hairy, deeply 2-dentate. Lodicules ca. 0.8 mm long, lanceolate, acuminate. Stamens 3; anthers 1.5–1.6 mm long. Ovary sparsely hairy near apex. Caryopses lanceolate; hilum linear, 2/5–1/2 of total length.

Distribution and habitat.—This species is known only from the Andean forest zone of Peru, at 2500–3250 m.

Etymology.—The specific epithet honors the eminent Peruvian botanist and agrostologist, Oscar Tovar Serpa.

Additional specimens examined: **PERU. Departamento Ayacucho. Prov. Huanta/La Mar. Tambo:** Wolken-Nebel Buschwald, 37 km to Ayna, 3250 m, 23 Mar 1977, *Ellenberg 7024* (USM). **Departamento Cajamarca. Prov. Cajamarca:** Road to Yumagual, 2500 m, 26 Jun 1966, *Vega 249* (USM).

DISCUSSION

In South America sect. *Subulatae* is represented by eight native species (Table 1). In this table we compare the salient morphological features that distinguish these taxa, including the North American species, *F. subulata* Trin. All the spe-

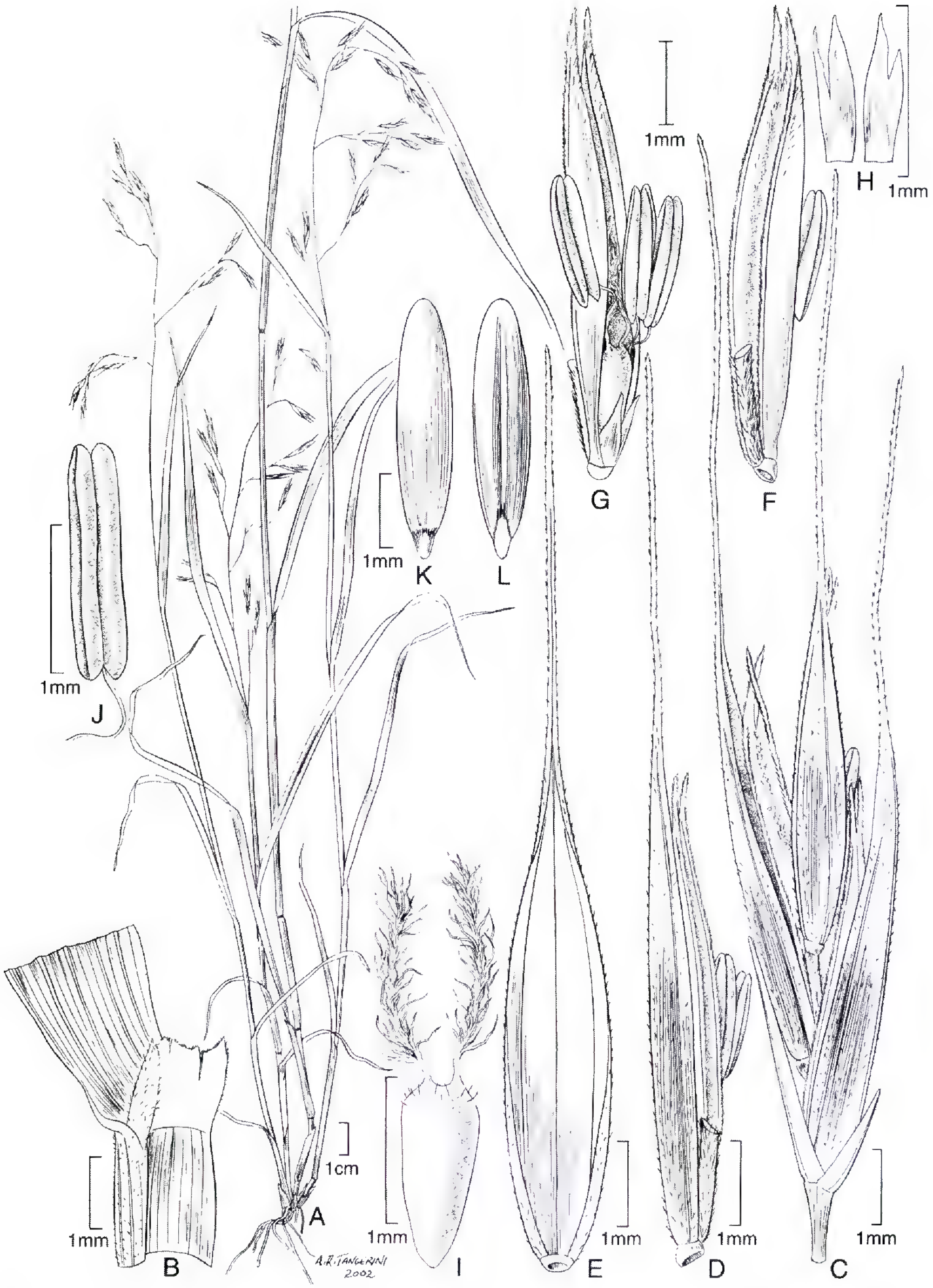


FIG. 2. *Festuca tovarensis* (*Tovar 2057*). A. Habit. B. Sheath, ligule, and portion of a blade. C. Spikelet. D. Floret. E. Lemma, ventral view. F. Palea with stamen. G. Palea, with lodicules, pistil, and stamens. H. Lodicules. I. Pistil. J. Stamen. K. Caryopsis, dorsal view. L. Caryopsis, ventral view.

TABLE 1. Morphological comparison of the South American species of *Festuca* sect. *Subulatae* and the North American *Festuca subulata*.

Taxon	*F. coromotensis*	*F . cochabambana*	*F. ulochaeta*	*F. cuzcoensis*	*F. tovarensis*	*F. flacca*	*F. sodiroana*	*F. parodiana*	*F. subulata*
geographical distribution	Venezuela	Bolivia	Argentina, Brazil, Colombia, Venezuela	Peru, Bolivia	Peru	Ecuador	Ecuador, Colombia	Argentina	North America
culm nodes	3–5	3–4	2–4	6–12	2–4	3–7	2–4	5–7	3–4
ligule size (mm)	0.5–1	0.2–0.7	0.3–1(–2)	2–3	1–2	3–3.5	0.5–1.1	1–2	0.5–1
form of ligule	truncate	truncate	truncate	acuminate	truncate	acuminate	truncate	truncate	truncate
spikelet size (mm)	11–15	9–10	9–12	8–10	7.5–9.5	7–8	7.5–9	10–13	8–10
number of florets	3–4	4–5	3–5	3–4	3	2–4	4–5(–6)	4–6	3–4
lower glume size (mm)	2.5–3	1.8–2.2	2.5–3.5(–4)	(2–)2.5–4.5	1.5–1.8	1.2–2.4	1.2–1.8	2–2.5	2.5–4
upper glume size (mm)	4.8–5.5	2.7–3.2	3.5–4.5	4–6	3.5–4.5(–5)	2.5–3.5	2.0–2.9	3–4	3.5–5
lemma size (mm)	8–8.5	5.5–6.2	6–8(–9)	7 8.5	5.5–6.5	6.5–7	5–6.5	7–8	6–8
awn size (mm)	0 0.5	6–12	7–15	3–4(–5)	5–7	9–12	awnless	awnless	5–10
form of awn	straight	straight	flexuous	straight	straight	straight	awnless	awnless	straight
anthers size (mm)	1.2–2	1–1.2	1.1–1.5	(1.2–)1.5–2	1.5–1.6	1.1–1.4	0.8–1.2	1.3	1.5 -2
tip of ovary	glabrous	hairy	sparsely hairy	sparsely hairy	sparsely hairy	sparsely hairy	glabrous	hairy	hairy

cies are morphologically very similar to one another. However, *F. ulochaeta* can be easily separated from the remaining seven species by having long-awned lemmas with the awn flexuous whereas the other taxa have straight awns or awnless lemmas. *Festuca cuzcoensis* and *F. tovarensis* are possibly most closely related to *F. flacca* since all three share lanceolate spikelets of the same size, 2–4 florets per spikelet, straight awns 3–12 mm long, and small anthers 1.1–2 mm long. *Festuca cuzcoensis* differs from *F. tovarensis* by having 6–12 nodes per culm (2–4 nodes in *F. tovarensis*), acuminate ligules (verses truncate), lower glumes (2–)2.5–4.5 mm long (verses 1.5–1.8 mm), lemmas 7–8.5 mm long (verses 5.5–6.5 mm), and a glabrous ovary (verses sparsely hairy). *Festuca parodiana* shares the following characteristics with *F. sodiroana*: truncate ligules, 4–6 florets per spikelets, and awnless lemmas. However, *F. parodiana* can be separated from *F. sodiroana* by having a hairy (glabrous in *F. sodiroana*) ovary, lower glumes 2–2.5 mm long (verses 1.3–1.8 mm), upper glumes 3–4 mm long (verses 2.2–2.9 mm), lemmas 7–8 mm long (verses 5–6.5 mm), and 5–7 nodes per culm (verses 2–4). *Festuca coromotensis* is almost awnless (mucronate) but differs from *F. sodiroana* and *F. parodiana* by having large, scabrous lemmas 8–9 mm long. There appears to be a geographic component as well since the principal area of distribution for *F. ulochaeta* is southeastern Brazil and northeastern Argentina with new range extensions reported from the Cordillera Oriental of Colombia and Cordillera de Mérida in Venezuela (Stančík 2001). The remaining seven species occur exclusively in the montane forest zone of the Andes in small endemic populations ranging from Argentina in the south to Colombia and Venezuela in the north. *Festuca elviae* Briceño, a Venezuelan species, is also a possible member of *Festuca* sect. *Subulatae*. However, further study is needed to confirm its inclusion in this section.

KEY TO THE SPECIES OF *FESTUCA* SECT. *SUBULATAE* IN SOUTH AMERICA

1. Lemmas awnless or with a mucro to 0.5 mm long.
   2. Lemmas 8–9 mm long, densely scabrous _____ **F. coromotensis**
   2. Lemmas 6.5–8 mm long, glabrous or papillate.
      3. Culms with 2–4 nodes; lower glumes 1.2–1.8 mm long; upper glumes 2.0–2.9 mm long; lemmas 5–6.5 mm long; ovary glabrous _____ **F. sodiroana**
      3. Culms with 5–7 nodes; lower glumes 2 2.5 mm long; upper glumes 3–4 mm long; lemmas *7*–8 mm long; ovary hairy _____ **F. parodiana**
1. Lemmas with awn 3–15 mm long.
   4. Lemma awns markedly flexuous, 7–15 mm long _____ **F. ulochaeta**
   4. Lemma awns straight, 3–12 mm long.
      5. Sheaths pubescent _____ **F. cochabambana**
      5. Sheaths glabrous, rarely scabrous.
         6. Lower glumes (2–)2.5–4.5 mm long; lemma awns 3–4 mm long _____ **F. cuzcoensis**
         6. Lower glumes 1.2–2.4 mm long; lemma awns 5–12 mm long.

7. Ligules 2 3.5 mm long; upper glumes 2.5–3.5 mm long; lemma awns 9–12 mm long _____ **F. flacca**

7 Ligules 1–2 mm long; upper glumes 3.5–4.5(–5) mm long; lemma awns 5 7 mm long _____ **F. tovarensis**

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BOOK REVIEW

JAMES D. MAUSETH, ROBERTO KIESLING, and CARLOS OSTOLAZA. 2002. **A Cactus Odyssey.** (ISBN 0-88192-526-8, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $39.95, 306 pp, 191 color photos, 4 maps, 6" × 9".

This book describes the history/evolution of cacti in South America showing the dynamic variety of habitats from high desert to low rainforest. *A Cactus Odyssey* is a fine addition to botanical literature based on experiences taken from the extensive careers of the authors in the region, along with numerous field trips in Bolivia, Argentina and Peru between the years 1995 and 2000. The hard work and combined expertise of three botanists, James Mauseth from Texas, Roberto Kiesling from Argentina, and Carlos Ostolaza from Peru led to the publication of this tour through the parts of South America that supports diverse cactus populations. Along with the unusual plants that are studied, the authors' interactions with the local peoples that are encountered, provides interesting perspectives on the areas where they traveled. A point of particular interest is the wide range of morphological differences among these cacti found in very different places. Dr. Mauseth has done extensive work on the anatomy and physiology of the Cactaceae. In the book, many points are made illustrating why certain cacti grow as they do, and why they are so well adapted to their sometimes harsh surroundings. The geological history of the Americas is also shown as a key factor in the evolution of Cactaceae.

Written not only for botanists, the terminology and amount of technical detail are well presented, giving the reader good definitions and descriptions. Included in the explanation of why the Cactaceae are only native to the Americas, the authors tell the reader what the common traits are among all cacti; those being the presence of areoles, clusters of spines, betalain pigments, and the characteristic structures of flower, fruit and seed. Those traits combine to make the cacti very different from similar looking plants from other continents. A discussion of the water storage system in and the special modifications of different tissues related to the environment, give the reader insight to the incredible process of survival that the cacti have developed living in such extreme environments. The herbarium specimen, seed and other collections taken for lab examination have given the authors thousands of hours of future lab work, as well as potential reams publishable data.

The book includes excellent photography; some very impressive photographs taken at high elevation show hillsides otherwise barren except for compact groups of densely spined cacti. The differences in growth habits from the high elevation to middle and low elevation populations are significant. Major changes in soil type and weather, as well as the beneficial relationships with other plants, increase the ability for cacti to have more vigorous growth. "Nurse" plants range from trees and shrubs in woodland areas, to tall grasses in prairies, to rain forests trees where the cacti are epiphytes on branches along with bromeliads. An interesting note taken of the cacti that are shown is how many of them look very similar to the tall growing saguaro cacti in Arizona. Close to 18 different genera are shown as tall, branching plants; but when examined closely they are very different from their North American cousins. The efforts of these three authors have provided an exciting tour through parts of the world seldom seen by travelers. This is enlightening work describing habitat and aspects of a spectacular plant family and its evolution never before considered by most people.

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A NEW SPECIES OF *ERIOGONUM* (POLYGONACEAE) FROM SOUTH TEXAS

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ABSTRACT

Eriogonum riograndis, sp. nov., is segregated from plants previously identified as *E. multiflorum* Benth. The new species is known from 17 counties of the Rio Grande plains in south-central Texas. *Eriogonum riograndis* differs from *E. multiflorum* in its broader leaves with auriculate-subclasping bases (vs. attenuate, non-clasping leaf bases) and its involucres with more numerous flowers (22–28(–36) vs. 6–12(–15) flowers). The two taxa are primarily allopatric and sharply discontinuous in morphology. Putative intermediates have been observed in three counties. Both species are distinct from the apparently closely related *E. annuum* Nutt. in their longer peduncles, sparsely tomentose and glabrescent involucres, and cordate perianth lobes.

RESUMEN

Eriogonum riograndis, sp. nov., se segrega de las plantas identificadas previamente como *E. multiflorum* Benth. La nueva especie se conoce de 17 condados de las llanuras de Río Grande en el sur-centro de Texas. *Eriogonum riograndis* difiere de *E. multiflorum* en sus hojas más anchas con bases auriculado-semiabrazadoras (en vez bases de las hojas atenuadas, no abrazantes) y sus involucros con flores más numerosas (22–28(–36) vs. 6–12(–15) flores). Los dos taxa son primariamente alopátricos y fuertemente discontinuos en su morfología. Se han observado intermedios putativos en tres condados. Ambas especies son distintas del aparentemente muy relacionado *E. annuum* Nutt. Por sus pedúnculos más largos, involucros esparsamente tomentosos y lóbulos del perianto glabrescentes, y cordados.

The Texas species of *Eriogonum* Michx. were treated in detail by Reveal (1968, 1970), who observed (1968, p. 203) that *E. multiflorum* Benth. and *E. annuum* Nutt. "are the most frequently collected species in the state and collectively the most widely distributed species." Together, they constitute subg. *Micrantha* (Benth.) Reveal (Reveal 1969). Reveal provided a set of detailed morphological contrasts to distinguish these two taxa, noting that their difference in perianth lobe shape allows easy identification. He did not call attention to significant infra-specific variation in either species.

The present study finds that plants previously identified as *Eriogonum multiflorum* can be separated into two, morphologically distinct sets of populations. Those occupying the largest part of the range in Texas, along with those from peripheral localities in northwestern Lousiana, southwestern Arkansas, and south-central Oklahoma (Fig. 2), are identified here as typical *E. multiflorum*. The type collection of *E. multiflorum* (Bentham, Trans. Linn. Soc. London 17:413. 1837) was made in 1833 by Thomas Drummond (Drummond

"between Brazoria and San Felipe de Austin," perhaps in what is now Austin County (from where a modern collection of *E. multiflorum* also has been made). An illustration based on the Drummond type material, presumably at K (Hook. Icon. Pl. 3, t. 250. 1840) shows leaves with non-clasping bases and the description notes "Involucres with about 6–9 flowers"—these features (see below) along with the general habit unambiguously establish the identity of the species. Observation of additional type material of *E. multiflorum* (GH photocopies!; isotype and syntypes fide annotations by J. Reveal in 1967) corroborate this. Plants identified as *E. multiflorum* in the Rio Grande plains of southern Texas represent a previously undescribed species.

Eriogonum riograndis Nesom, sp. nov. (**Figs. 1, 2**). TYPE: U.S.A. TEXAS. SAN PATRICIO CO.: 9 mi E of Sinton, Welder Foundation Research Area, near headquarters buildings, grassy field along swale and in swale, 28 Oct 1958, *F.W. Gould 8510* (HOLOTYPE: BRIT-SMU!; ISOTYPES: TAES!, UC).

Eriogono multifloro Benth. similis duratione annua, caulibus foliosis tomentosis, periantho stipitato, et lobis externis perianthii oblongi-cordatis; differt foliis majoribus ad basim auriculati-subamplectentibus et involucris floribus plus numerosis.

Annual or biennial herbs from a taproot, eglandular. **Stems** erect, 2.5–6(–11, –20 fide Reveal 1970, Richardson 1995) dm tall, usually unbranched until the inflorescence, closely but loosely gray-white and persistently woolly-tomentose. **Leaves** mostly on the lower 3/4–4/5 of the stem, basal not persistent, alternate, oblong-obovate to oblong-elliptic or oblong, epetiolate and shallowly auriculate-subclasping, apex rounded to obtuse, 15–40(–45) mm long, 10–22(–25) mm wide, margins flat or narrowly revolute, entire but often closely undulate, upper surface lightly but persistently woolly-tomentose, lower surface densely and persistently white- to tawny-tomentose. **Inflorescences** cymoid, usually relatively compact. **Involucres** on peduncles 2–5 mm long, turbinate to turbinate-campanulate, 2–2.8 mm high, 2–3 mm wide, 5(–6)-lobed, externally sparsely but persistently tomentose to glabrate, internally densely tomentose. **Flowers** 22–28(–36) per involucre, exserted from the involucre on filiform pedicels. **Perianth** bright white to pinkish, maturing or drying orangish, externally glabrous, internally sparsely tomentose; perianth lobes dissimilar, outer lobes basally cordate and broadly oblong to oblong-elliptic, 2–2.7 mm long, 1.5–2.2 mm wide, midrib thick from base to apex, inner lobes linear, 0.1–0.2 mm wide. **Fruits** dark brown to red-brown, 1.9–2.2 mm long, not winged, glabrous.

Habitat and phenology.—Fields, pastures, roadsides, mesquite prairies, oak woodlands, and other open habitats, sandy soil; (Aug–)Sep–Nov(–Dec).

Distribution.—The distribution of *Eriogonum riograndis* (Fig. 2) corresponds to phytogeographic pattern #17 of Sorrie and Weakley (2001): South Texas-Northeast Mexico Mesquital. They note that "The northern portion is commonly denoted as the South Texas Plains, but ecologically the whole area



FIG. 1. Habit and details of *Eriogonum riograndis* (from holotype, BRIT).

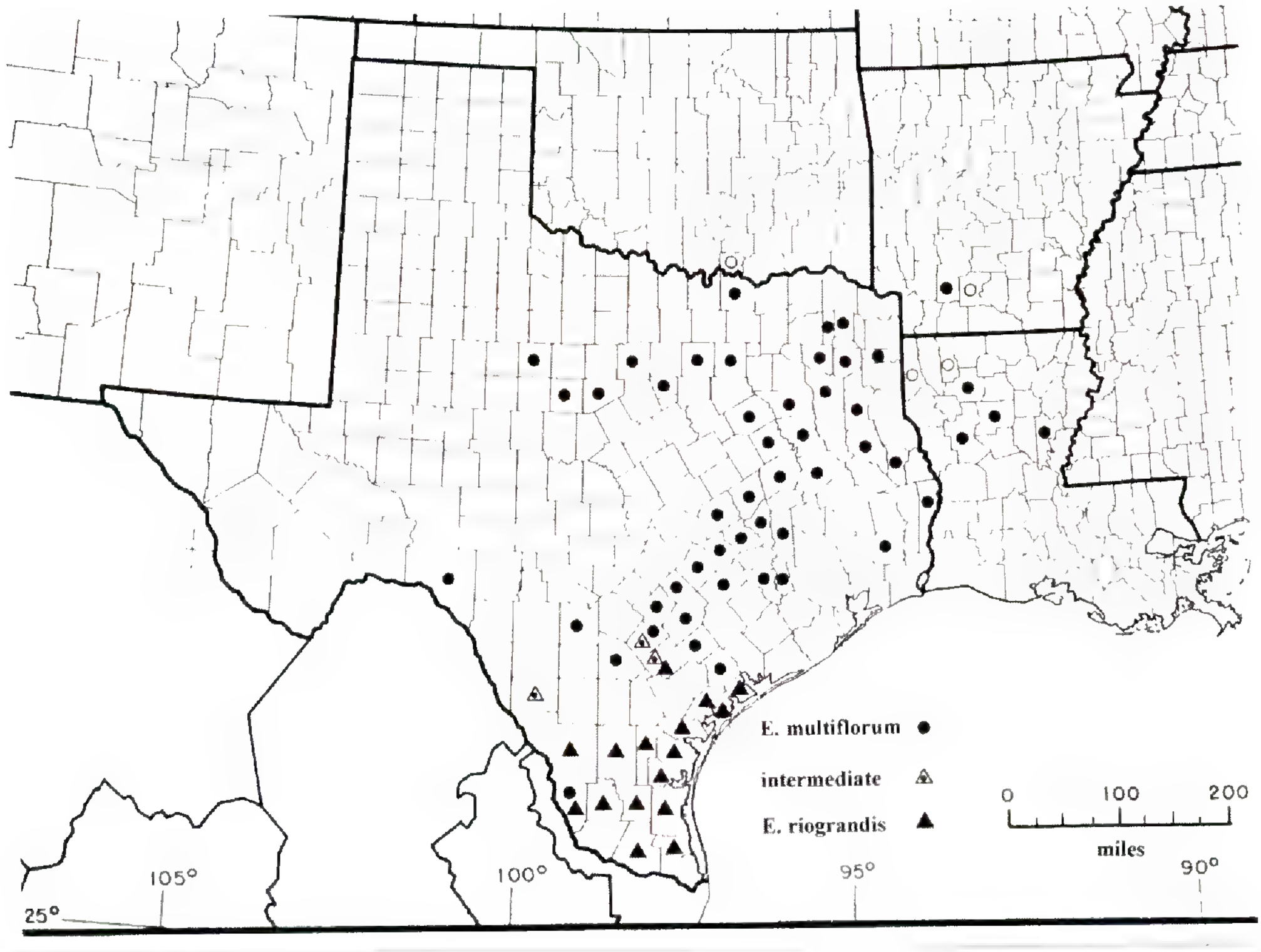


FIG. 2. Geographic distribution of *Eriogonum riograndis* and *E. multiflorum*. Records are from BRIT-SMU, CAMU, OKLA, TAES, TEX-LL, and VDB. Open symbols represent records from collections not seen in this study but added from Smith (1988) and MacRoberts (1989) and from photocopies of Oklahoma specimens from OKLA.

is more properly termed the Tamaulipan Scrub region, or Tamaulipan Mesquital, due to the dominant shrubby vegetation, especially *Prosopis glandulosa* Torr. ..." (Sorrie & Weakley 2001, p. 61). The distribution of the recently described *Pseudognaphalium austrotexanum* Nesom (Nesom 2001) also fits the same phytogeographic pattern. Reveal (1970) noted that *E. multiflorum* occurs in Mexico; presumably this would be *E. riograndis* in the interpretation here, but a specimen documenting the Mexican distribution has not been seen in the present study.

Etymology.—The appositive epithet refers to the central geographic feature in the range of the new species, the Rio Grande (river).

Additional collections examined. **U.S.A. Texas. Aransas Co.:** 4.7 mi E of Rockport, 19 Sep 1936, *Parks* and *Cory 20336* (TAES); Aransas Refuge, 30 Sep 1944, *Cory 45936* (TAES); St. Joseph Island, irregular dunes beyond back beach, 7 Nov 1964, *Andrews 72* (TEX); Aransas Wildlife Refuge, sandy soil at Equipment Shed, 18 Sep 1968, *Fleetwood 9317* (LL); sandy soil along Hwy 35 ca 5 mi N of Rockport, 26 Sep 1981, *Brown 5421* (TAES); 1/2 mi N of Goose Island State Park on Park Road 13, common in clearing in oak woodland, 29 Dec 1982, *Fryxell 3836* (BRIT, TEX). **Brooks Co.:** 3 mi E of Encino, 6 Jul 1935 [sterile], *Parks* and *Cory 141421* (TAES); 14 mi S of Falfurrias, sandy oak region, 15 Sep 1942, *Lundell 11941* (LL); a few mi E of Jim Hogg Co. line on Rd 755, loose sand prairie, 13 Sep 1954, *Johnston 541455*

(TEX); 4 mi SE of King Ranch, Encino Division Headquarters, in deep, loose sand blow-out area, 18 Nov 1954, *Gould* and *Morrow 6705* (SMU, TAES, TEX); 15 mi E of Hebbronville on State Hwy 285, in Pleistocene gravel, 25 Nov 1962, *Dohnke 6* (SMU, TEX); 12 mi E of Hebbronville, Hwy 285, 10 Nov 1962, *Solis 48* (TAES, TEX); 4.6 mi S of FR 2191 (extension) from its jct with TX 285, Mariposa ranch gate, SE of Falfurias, open hillside to edge of oak mott with deep sandy soil, 31 Oct 1990, *S. & G. Jones 6081* (VDB). **Calhoun Co.:** Matagorda Island, 1955, *Ball s.n.* (TAES); Matagorda Island, access road from air base HQ to beach at end of island, ca 2 mi E of base, 22 Jul 1973 [not flowering], *Hartman 3722* (TEX). **Duval Co.:** Benavitas, 340 ft, 12 Aug 1941, *Fisher 41101* (TEX). **Hidalgo Co.:** N of Edinburg, 11 Nov 1942, *Walker 126* (LL); ca. 30 mi N of Edinburg, in sand, 23 Aug 1944, *Whitehouse 44,276* (SMU); Bentsen Ranch, 10 mi N of Edinburg, in sand, 2 Nov 1973, *Everitt s.n.* (SMU); La Reforma Training Area (Texas National Guard), N end of Sector C, openings in mixed mesquite-blackbrush shrubland on dry level upland, 6 Oct 1993, *Carr 13177* (TEX); La Reforma Training Area (Texas National Guard), along main N-S road, 1.4 road mi N of gate 24, grazed grassland on gently rolling upland with scattered mesquite, 255 ft, 25Oct 1994, *Carr 14302* (TEX). **Jim Hogg Co.:** State Hwy 285 E of Thompsonville, in light brown loose sand, 11 Nov 1962, *Ramirez, Alva, and McCart 8708* (SMU, TAES, TEX); 10 mi N of La Gloria on Texas Farm Rd 1017, 15 Oct 1990, *Miller, Brant, & Noyes 5811* (VDB); E side of FM 1017, 3.0 road mi S of jct with smaller road at Agua Nueva, ca. 450 ft, occasionally mown grassland in deep loose sandy soil, roadside, 7 Oct 1993, *Carr 13208* (TEX). **Jim Wells Co.:** sandy loam in dry lake, Romarsid Ranch, 1 Nov 1943, *Freeborn 142* (TEX). **Karnes Co.:** 2 mi S of Karnes City, frequent in dry, deep sandy soil, fallow field, 27 Oct 1952, *Johnson 1010* (LL, SMU, TAES); 3 mi NE of Kenedy, dry Escondido Creek, infrequent in dry sandy loam soil, 25 Jul 1954 [very early bud], *Johnson 1618* (SMU). **Kenedy Co.:** 18.7 mi N of Raymondville, frequent along road in sandy soil, 2 Dec 1945, *Cory 51495* (SMU); Norias Division of King Ranch, Saltillo Pasture, 14 Sep 1953, Johnston s.n. (TAES, TEX), 17 Sep 1953, Johnston s.n. (TAES, TEX), 24 Nov 1953, *Johnston s.n.* (SMU, TAES, TEX); 18 mi S of Riviera, dune area, 12 Oct 1952, *Morrow* and *Nord 19* (TAES); Norias Division of King Ranch, SE corner of ranch, open sandy coastal plain, 23 Sep 1958, *Lundell and Correll 15155* (BRIT, LL); 3.4 mi N of Armstrong, fine gray sand, 6 Nov 1953, *Shinners 17082* (SMU). **Kleberg Co.:** Padre Island, 17 Nov 1940, *Cory 36795* (SMU), *Cory 36796* (TAES), *Cory 36797* (TAES), *Cory 36798* (SMU), *Cory 36799* (TEX); Kingsville, summer 1940, *Sinclair s.n.* (TEX); Laureles Division of King Ranch, loose sand, 15 Sep 1953, *Johnston s.n.* (TEX), 29 Nov 1953, *Johnston s.n.* (TEX); Brooks County line on Road No. 285, loose sand mesquite prairie, 14 Sep 1954, *Johnston 541513* (SMU, TEX); Padre Island National Seashore, end of service road to dump area, small stabilized dunes near margin on brackish back island pond, 14 Oct 1989, *Lemke 3009* (TEX). **Nueces Co.:** Copano Bay, 5 Oct 1922, *Tharp 1552* (TEX); Corpus Christi, 18 Dec 1935 [past fruit], *Parks 17437* (TAES), *17438* (TAES); Mustang Island, loose sand, 26 Oct 1954, *Hildebrand 82* (TEX); Mustang Island, sand dunes 300 yds from Gulf, 11 Nov 1965, *Crutchfield 1027* (LL); Mustang Island cemetery, Port Aransas, sandy soil near fence, 14 Oct 1967, *Gillespie 110* (TEX); Mustang Island, Shamrock Bay area, west side of island, 29 Jul 1967, *Gillespie 200* (TEX); Mustang Island State Park, NW of Park Rd 53, 500 ft SW of Corpus Christi Pass, dry sand along elevated margin in tidal flat, 500 ft, 20 Oct 1989, *Carr 10158* (TEX). **Refugio Co.:** Black Jacks below Austell, 4 Dec 1928, *Phipps s.n.* (TEX). **San Patricio Co.:** 1.8 mi SW of Aransas Pass, 19 Sep 1936, *Parks* and *Cory 20338* (TAES); 4 mi SW of Ingleside, 19 Sep 1936, *Parks* and *Cory 20339* (TAES); 2 mi SE of Ingleside in deep fine sand, 2 Oct 1950, *Jones 383* (SMU); 1 mi S of Ingleside in deep fine sand, 8 Jun 1951 [pre-flowering], *Jones 565* (SMU); Welder Wildlife Refuge ca. 13 mi E of Sinton, high banks above Aransas River in Mare Trap Pasture, occasional in tight sandy loam, 29 Sep 1956, *Rowell 5212* (SMU). **Webb Co.:** 3 mi S of Mirando City at Los Ojuelos, in grayish black loose sand, 10 Oct 1961, *Magnon* and *Rodriguez 14* (SMU). **Willacy Co.:** Yturria, 50 ft, 6 Aug 1924 [not in flower], *Runyon 665* (TEX); along hwy from Yturria Station north, 24 Sep 1937, *Runyon 1808* (TEX); Yturria, open dry sandy ground, 10 m, 22 Sep 1939, *Runyon 4237* (TEX); Raymondville, 5 Jul 1941, *Shiller 759* (TAES, TEX); Sauz Ranch, sand, 23 Nov 1953, *Johnston* and *Davis s.n.* (SMU, TAES, TEX). **Zapata Co.:** 7 mi N of Zapata, US Hwy 83, 15 Nov 1961, *Munoz, McCart*, and *Cabrera 39* (SMU, TEX).

Eriogonum multiflorum and *E. riograndis* can be distinguished by a simple visual inspection relying primarily on leaf morphology. A count of flowers per involucre, usually requiring low magnification, confirms their distinction. Morphological differences between the two are summarized in the following contrast.

1. Leaves oblong-obovate to oblong elliptic or oblong, 1.5–4(4.5) cm long, 10 22(25) mm wide, auriculate-subclasping at the base, upper surfaces persistently tomentose to weakly glabrescent, usually grayish; flowers 22–28(–36) per involucre _____ **Eriogonum riograndis**

1. Leaves mostly narrowly elliptic-lanceolate to narrowly lanceolate, 2–5(–8) cm long, 3–9(15) mm wide, attenuate at the base, rarely rounded, but not auriculate subclasping, upper surfaces glabrescent to glabrate, commonly reddish; flowers (6 -)9–12(16) per involucre _____ **Eriogonum multiflorum**

These two taxa are similar in habit and overall morphology, and they apparently have a sister relationship. *Eriogonum riograndis* is similar to *E. multiflorum* in its annual duration, leafy and tomentose stems, cymose inflorescence with pedunculate involucres, stipitate perianth internally pubescent but externally glabrous, and dissimilar perianth lobes (outer oblong-cordate, inner linear). They have similar phenologies and both occur in sandy habitats. As a pair, these taxa differ from *E. annuum* in their oblong-cordate outer perianth lobes (vs. obovate and basally attenuate) and sparsely tomentose, commonly glabrescent involucres (vs. densely and persistently tomentose). The involucres of *E. annuum* also are on shorter peduncles (subsessile to 1–3 mm long), often giving the inflorescence branches a somewhat secund appearance, and each involucre produces 25 or more flowers (similar to those of *E. riograndis*).

Eriogonum riograndis and *E. multiflorum* are primarily allopatric in geographic range (Fig. 2), but *E. multiflorum* has been documented within the range of *E. riograndis*.

Zapata Co. *E. riograndis* and *E. multiflorum* both have been collected here. Plants of the latter (*Hamby 1711*, TEX) are typical in leaf morphology and flower number, as are plants of *E. riograndis* (citation above).

A few plants with apparently intermediate features have been collected (Fig. 2).

Dimmit Co. (18 mi E of El Indio, *Miller et al. 5775*, TAES): leaves narrow, sessile but flowers 36 per involucre. This plant has leaves of *E. multiflorum* but a high number of flowers like *E. riograndis*. *Hoglund s.n.* (Carrizo Springs, TEX) has narrow, sessile leaves but 20–21 flowers per involucre.

Karnes Co. (2 mi S of Karnes City, *Johnson 1010*, LL, SMU, TAES): leaves relatively narrow and strongly glabrescent but those on the upper 2/3 of the stem basally truncate to subauriculate and subclasping; involucres 18–27-flowered (tending toward intermediate in flower number). These plants are identified here as *E. riograndis*. Another from Karnes Co. (*Johnson 1618*, SMU) is florally

immature but similar in leaf morphology to *Johnson 1010*, but the tendency for smaller number of flowers and the sessile lower leaves indicate that genes from *E. multiflorum* may be present.

Wilson Co. (Kicaster, *Parks Rx 3016*, TEX): upper leaves clasping to subclasping, flowers ca. 18–22. This plant is similar to those of *Johnson 1010* in Karnes Co., apparently intermediate. *Parks* and *Cory 11800* (E of Floresville, TAES) has narrow sessile leaves but 24 flowers. *Parks 5355* (Kicaster school, TAES) is typical *E. multiflorum*.

Choice of rank.—Conspicuous morphological and geographic discontinuity between *Eriogonum multiflorum* and *E. riograndis* is the predominant feature of their contrast. Putative morphological intermediates suggest that hybridization may occur where they come into geographically close contact, but no zone of intergradation exists to suggest that significant gene flow occurs between the two taxa. It might be argued that their apparent sister relationship should be recognized by treating them as varieties within a single species, but the degree of morphological differentiation between species in any given genus (including *Eriogonum*) is variable, and the discontinuity documented here (with inference of genetic isolation) provides justification for treating *E. multiflorum* and *E. riograndis* at specific rank, consistent with species concepts in many other genera.

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A NEW VARIETY OF *IPOMOEA COSTELLATA* (CONVOLVULACEAE) FROM THE EDWARDS PLATEAU REGION OF TEXAS

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ABSTRACT

Ipomoea costellata var. ***edwardsensis***, var. nov., is described, illustrated, and mapped. It apparently is endemic to the Edwards Plateau region of Texas, where it is known from six counties. It is set apart from *I. costellata* elsewhere in its range by its combination of shorter peduncles and bright white, nearly rotate flowers with fewer and deeper lobes.

RESUMEN

Se describe, se ilustra y se cartografía ***Ipomoea costellata*** var. ***edwardsensis***, var. nov. Es aparentemente endémica de la región de la meseta Edwards de Texas, de donde se conoce de seis condados. Se separa de *I. costellata* por su combinación de pedúnculos más cortos y flores blanco brillante, casi rodadas con menos lóbulos y más profundos.

Plants of a small-flowered, pedatisect-leaved morning glory from the Edwards Plateau region of Texas are identified as *Ipomoea costellata* Torrey but are distinct from other plants of the species in morphology, phenology, and geography. The Edwards Plateau plants are here recognized as a distinct variety.

Ipomoea costellata Torrey var. **edwardsensis** O'Kennon & Nesom, var. nov. (**Figs. 1, 2, 3**). TYPE: U.S.A. TEXAS. TRAVIS CO.: Colorado River, Montopolis Bridge, 8 Nov 1934, *B.C. Tharp s.n.* (HOLOTYPE: TEX).

Differt a *I. costellatae* Torrey sensu lato pedunculis brevioribus longitudine petiolum aequantibus et corollis albis rotatis lobis paucioribus profundioribus.

Plants annual herbs from a filiform taproot, at first erect, becoming prostrate or clambering on low vegetation, slightly twining at the very tips. ***Stems*** simple or with 1–5 (or more) branches originating ca. 2–4 cm above the base, terete, 3–60 cm long, 0.5–1 mm in diameter, branching, green, glabrous. ***Leaves*** pedatisect, 2–3.5 cm wide, petioles 7–25 mm long, nearly even in length or decreasing slightly from base to apex of stem, glabrous, ultimate leaf segments 7–9(–11), linear to linear-lanceolate, unequal, the longest 15–24 cm long, 1.5–3 mm wide, outer shorter than the inner and usually lobed from near the base, green above and beneath, glabrous, margins entire, sparsely hispid-ciliate, apices acute, apiculate. ***Flowers*** solitary or less commonly paired; peduncle spreading to slightly decurved or ascending, terete, filiform, 3–22 mm long, green, glabrous to sparsely



FIG. 1. Habit and floral details of *Ipomoea costellata* var. *edwardsensis* (from *O'Kennon 8125*).





FIG. 2. Photographs of *Ipomoea costellata* var. *edwardsensis* flowers (from *Nesom FW99* and *O'Kennon*).

hispid-pilose; pedicel 6–8 mm long, slightly thicker than the peduncle, separated from the peduncle by a pair of awl-shaped bracts, glabrous to sparsely hirsute-pilose; sepals equal, subimbricate, elliptic to elliptic-lanceolate, 4–5.2 mm long, 1.5–2 mm wide, midrib green, low-carinate, smooth to muricate, margins entire, hyaline, the apex rounded to retuse, apiculate; corolla tubular to long-campanulate, all parts bright white, glabrous, 8–11 mm long, tube 4–5 mm long, 2 mm in diameter, limb with 5 oblong-ovate, apiculate, spreading lobes 2–2.5 mm long, flowers opening with lobes nearly erect, spreading at right angles at full anthesis, closing erect past maturity; stamens subequal, white, filaments pubescent along whole length with long, viscid trichomes; style white, 4.5 mm long (equaling the filament length), glabrous, stigma white, slightly bilobate, apparently in contact with the anthers. ***Fruits*** bilocular dehiscent capsules 5–6 mm in diameter, tan upon drying, chartaceous, glabrous; seeds 4, dark brown to blackish, obovoid, 3-angled, ca. 3 mm long, 2 mm wide, densely and minutely strigose.

Additional collections examined. **United States. Texas. Bexar Co.:** Government Canyon State Natural Area, E side of Wildcat Canyon, E edge of San Geronimo Quad or W edge of Helotes Quad, 'guesstimated' lat/long—29° 33'51" N, 98° 45'00" W, elev. 1200–1240 ft, rare, two plants seen among sparse herbaceous vegetation in very shallow dark brown clay in natural opening on Cretaceous limestone bedrock exposed on flattest part of ridgetop, associates include *Sporobolus vaginatus*, *Bothriochloa ischaemum* var. *songarica*, *Croton monanthogynus*, *Senna lindheimeriana*, 24 Oct 1995, *Carr 15050* (TEX). **Burnet Co.:** N of RM Road 1431, 1.8 road mi WNW of US Rte 281, Marble Falls Quad, local in thin, fairly dry, organic-sandy soil in unshaded weather pit on low granite outcrop, ca. 1500 ft elev., annual, stems twining only at tips of taller plants, 18 Aug 1988, *Carr 9136* with Kutac, Lynch, and Brown (TEX); RM Road 1431, 1.7 mi W of jct with US Rte 281 in Marble Falls, area of exposed granite, N side of road across from large quarry, 23 Oct 2001, *Nesom FW99* and O'Kennon (BRIT, TEX). **Gillespie Co.:** Onion Creek Bluff, 400 m E of FM 783 in NW Gillespie Co., scarce in limestone crevices 10 m above Onion Creek, 19 Oct 1990, *O'Kennon 8125* (BRIT). **Llano Co.:** near the summit of Dutch Mountain, ca. 1.5 mi N of Enchanted Rock, infrequent vine, 29 Sep 1976, *Butterwick and Lamb 3303* (TEX). **Travis Co.:** Austin, Colorado River below Dam, 29 Sep 1929, *Ecology Class s.n.* (TEX); Austin, Onion Creek, 15 Oct 1929, *Whitehouse W-29-3* (TEX); McKinney Falls State Park, S of Onion Creek at mouth of Williamson Creek, frequent, locally abundant in thin soil in weather pits on exposed calcareous bedrock, ca. 100–300 ft, 29 Oct 1985, *Carr 7050* (BRIT, TEX). **Uvalde Co.:** 2.1 mi W of jct of FM 127 and FM 1049 on FM 127, dry limestone ledge, 2 Nov 1985, *Keeney 5371* (BRIT).

Etymology.—The epithet alludes to the location of the plants on the Edwards Plateau.

Distribution, habitat, and phenology.—Collections at hand indicate that *Ipomoea costellata* var. *edwardsensis* is distributed over the Edwards Plateau, although the plants are apparently uncommon and inconspicuous. Shinners' treatment of Texas *Ipomoea* (1970) noted only that *I. costellata* occurs in the trans-Pecos region, although in 1960 he annotated the three early collections from Travis County (1929 and 1934, cited above) as *I. costellata*; McDonald (1995) did not map or cite any collections of *I. costellata* from the Edwards Plateau. We suspect that searches for var. *edwardsensis* will broaden its known distribution

but confirm that it is endemic to the Edwards Plateau. Limestone ledges and crevices, and thin soil of weather pits in bedrock of limestone and granite, 100–1500 ft elev. Flowering (August–)September–November. We observe that var. *edwardsensis* apparently is particularly sensitive to grazing.

Ipomoea costellata (excluding var. *edwardsensis*) occurs in Texas in the trans-Pecos region and in Webb Co. (Fig. 3), continuous with its distribution in the Mexican states of Chihuahua and Coahuila. It is recorded from all of the northernmost states of Mexico (Sonora, Chihuahua, Coahuila, Nuevo León, and Tamaulipas) except Baja California and continues southward to Guatemala (see McDonald 1995, Fig. 2). Austin and Huáman (1996) reported its occurrence also in Venezuela but not Guatemala.

A recent taxonomic revision (McDonald 1995) treats *Ipomoea costellata* and seven closely related species within *Ipomoea* sect. *Leptocallis* (G. Don) J.A. McDonald, and another species has been recently added (Austin & Tapia Muñoz 2001). *Ipomoea costellata* is distinct within sect. *Leptocallis* in its annual, taprooted habit and small flowers (ca. 1 cm long). *Ipomoea costellata* alone in the section is autogamous—self-pollination is facilitated by the stigma in contact with stamens. Variety *edwardsensis* also has this reproductive arrangement and is obviously closely related to the rest of the species, but its geographic separation and set of differences (couplet below) provide a reasonable basis for formal taxonomic recognition.

Peduncles 3–22(–30) mm long, peduncle plus pedicel mostly shorter than or equal to the subtending leaf, ca. equal the petiole length; corollas bright white, with five, oblong-ovate lobes; flowering (Aug-)Sep–Nov _____ **Ipomoea costellata** var. **edwardsensis**

Peduncles (15–)27–70 mm long, peduncle plus pedicel mostly 1.5–3 times longer than the subtending leaf; corollas pink, purple, bluish, white, or yellow, with ten, shallowly rounded lobes; flowering (Jun–)Jul–Oct _____ **Ipomoea costellata** var. **costellata**

Ipomoea flowers are fragile and commonly are not useful for taxonomic distinctions in pressed specimens. We emphasize the short peduncle length, especially of mature fruits, as the most obvious and easily observed feature to distinguish var. *edwardsensis*. Scattered plants of *I. costellata* sensu lato (var. *costellata*) may have peduncles approaching the short length of var. *edwardsensis*, but the latter (as a population system) is set apart from rest of the species by this feature.

The flower color of *Ipomoea costellata* was described by McDonald (1995) as "blue, or rarely yellow throughout." Other sources note the following: "pale lavender" (Texas—*Whitehouse 17154*, SMU), "pale pink" (Texas—*Turner et al. 53447*, SMU), "reddish" (Texas—*Keough 227*, TEX), "purple" (Texas—*Butterwick and Lamb 1759*, TEX), "rose-purple" (New Mexico—Martin & Hutchins 1981), lavender (photo of Texas plant—Rickett 1969), "limb pale pink, throat and tube near white" (New Mexico—*Spellenberg 3852*, LL), "lavender or purplish, tube paler" (Sonora—Wiggins 1964), "tube lavender, purple near tips, yellow-white

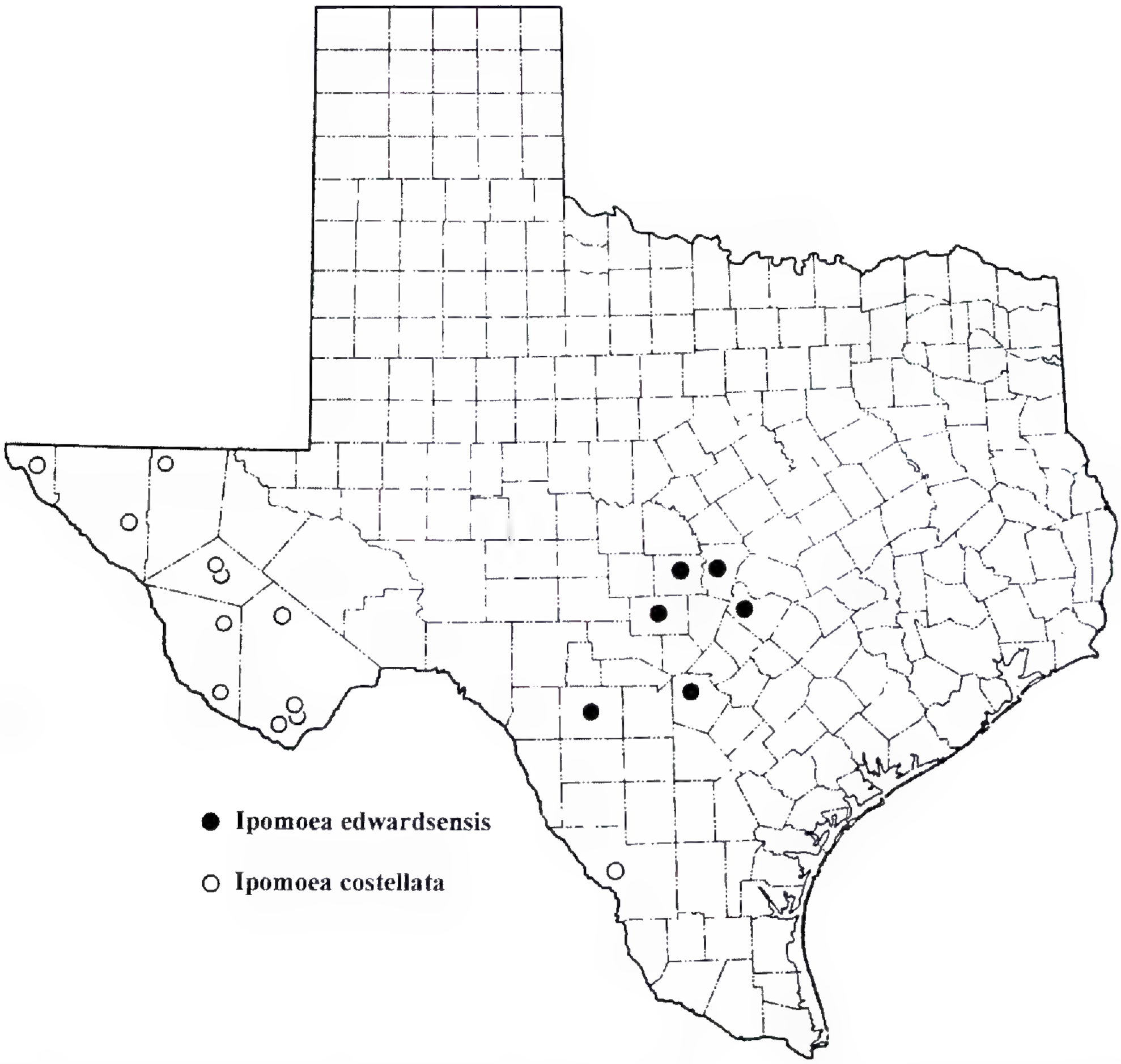


FIG. 3. Distribution of *Ipomoea costellata* var. *edwardsensis* and *I. costellata* var. *costellata* in Texas. The range of var. *costellata* continues westward to Arizona and southward to Guatemala (see text). Records are from BRIT-SMU and TEX-LL.

at base" (Chihuahua—*Henrickson 7557*, TEX), "yellow tube, purple-red limb" (Chihuahua—*Henrickson 7692*, TEX), "cream with green-yellow throat" (Coahuila—*Wendt 1783*, TEX), and "pale blue" (Chiapas—*Breedlove 52353*, TEX). Plants in the vicinity of Edo. Mexico produce yellow flowers (according to McDonald) and have been segregated as *I. painteri* House—this taxon was included in the synonymy of *I. costellata* by McDonald but treated as distinct by Rico R. (1985), who described the flower color of *I. painteri* as white or creamy. Plants in Nuevo León and Tamaulipas also apparently produce white flowers and are further distinguished within the species by thick taproots and apparently perennial duration; peduncles of these plants are long.

The corolla morphology of var. *edwardsensis* also is distinctive from any we are aware of within *Ipomoea costellata* and certainly from populations of the species on the periphery of var. *edwardsensis* in Texas and northern Mexico.

In var. *edwardsensis*, the limb is deeply and relatively narrowly lobed, and at full anthesis, the lobes spread at nearly right angles to the tube (Fig. 2). The line drawing (Fig. 1) shows a flower as it appears in early anthesis, just opening. Flowers of *I. costellata* elsewhere in its range apparently have ten, shallow lobes and the limb is funnelform, widening gradually toward the apex (Rickett 1969, pl. 99; Warnock 1977, Fig. 6, p. 178)—"corolla campanulate ... limb subentire, scantily 10-lobate," as described by McDonald (1995, p. 106).

Variety *edwardsensis* is clearly a 'satellite' of the larger and variable *I. costellata* sensu lato. Recognition of var. *edwardsensis* emphasizes its relative internal consistency and its morphological and geographical distinction from the rest of the species. Other recognizable geographic variants, particularly as distinguished by flower color, have been formed within *I. costellata*, this process perhaps quickened by the apparent tendency for autogamy. Formal recognition of the Edwards Plateau populations implies that other geographic segments of *I. costellata* might also be justifiably recognized (McDonald pers. comm.), and we agree with this.

McDonald (1995) did not provide a formal statement of his concept of varietal versus specific rank within sect. *Leptocallis*, but several species in his treatment include geographically distinct varietal taxa separated by one to several apparently non-intergrading morphological characters. In contrast, Yatskievych and Mason (1984) recognized two varieties within *I. tenuiloba* Torrey (of sect. *Leptocallis*) that are morphologically intergrading, this taxonomy accepted by McDonald. Yatskievych and Mason also observed that *I. tenuiloba*, *I. capillacea* (Kunth) G. Don, and *I. plummerae* A. Gray (including *I. patens* (A. Gray) House) constitute "a very close-knit species complex." With further consideration of the rationale for applying ranks within sect. *Leptocallis*, we believe that the Edwards Plateau variety of *I. costellata* eventually may be treated at higher rank.

ACKNOWLEDGMENTS

We are grateful to the staff of TEX-LL for their help during recent visits. Andrew McDonald and Dan Austin reviewed the manuscript and we are grateful to Andrew McDonald for a discussion of variation in *I. costellata*. Linny Heagy provided the fine illustration.

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BOOK REVIEW

STEPHEN ANDERTON. 2001. **Urban Sanctuaries: Peaceful Havens for the City Gardener.** (ISBN 0-88192-502-0, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $29.95, 144 pp, 148 color photos, 4 color plans, 4 b/w plans, 8 1/2" × 11".

Creating a "sanctuary" is a popular topic, turning up frequently in the recent crop of gardening literature. British garden writer Stephen Anderton shows how you can create a peaceful oasis in a hectic environment. The emphasis in *Urban Sanctuaries* is on the traditional backyard, but Anderton's key concepts will apply to smaller and more exotic areas as well. Anderton's approach is a down-to-earth yet inspiring presentation of alternatives ranging from cutting-edge designs of cool contemporary plots to family-oriented backyards and container gardens that make maximum use of minimum space.

Anderton's concepts remain constant throughout his narrative. In *Part One: The Body of the Garden* he addresses the fundamental basics of garden design. What type, full or partial, and time of sun does the plot receive? What type of soil does your garden have? What plants or design elements are already there, and will you include them or not? What is your preferred planting style: traditional, tropical, minimalist? Do you want to incorporate a water feature? The scale of plantings as well as water and soil supplies must be considered carefully. To make it seem larger, the pace of movement through the area should be slowed and there must be a place to sit, which seems obivious, but during the design stage the fact that eventually one will want to spend leisure time in one's garden is often overlooked. The broad scope of his vision encompasses all categories of stylistic considerations, with the aim of directing the reader to a design path best suited to one's fundamental predilections. By looking at innovative designs for varied styles of urban gardens Stephen Anderton shows how they can be adapted to create outdoor spaces that are not only imaginative but are also imbued with a mood of peace and serenity.

Part Two: The Spirit of the Garden follows Anderton's musing on different garden themes and ideas of how to make those themes a reality. He uses case studies to provide design solutions complete with diagrams for gardens with magic with mystery, the natural approach, devoted to water, minimalist style, and more. A selected directory, complete with US hardiness zones, of 72 plants that meet his criteria of those that are "tough, easy to grow, and ... have a long season". Plants selected range from trees to perennials.

A prominent personality in the world of English gardening, Stephen Anderton writes a Saturday column for *The Times* (London) and regularly contributes to *Horticulture, The Garden, and Gardens Illustrated*. This unique resource for the city dweller should appeal to gardeners of all levels. *-Gary Jennings, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A.*

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SPHAERALCEA CAESPITOSA VAR. *WILLIAMSIAE*, VAR. NOV. (MALVACEAE)

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ABSTRACT

In Railroad Valley of east-central Nevada is a less densely pubescent, thinner-leaved, and somewhat smaller-flowered version of *Sphaeralcea caespitosa* of west-central Utah. This variety is described as new, *S. caespitosa* var. *williamsiae* N.H. Holmgren.

KEY WORDS: Malvaceae, Great Basin flora, *Sphaeralcea caespitosa* var. *williamsiae*

RESUMEN

En el valle Railroad del centro-este de Nevada está una versión de *Sphaeralcea caespitosa* con pubescencia menos densa, hojas finas, y flores algo más pequeñas que la del centro-oeste de Utah. Se describe como una nueva variedad, *S. caespitosa* var. *williamsiae* N.H. Holmgren.

The genus *Sphaeralcea*, consisting of about 40 species, is found in temperate and warm temperate parts of North and South America. It is a difficult genus taxonomically with poorly delimited species. Frequent hybridization and back-crossing may be the culprits. In North America there are about 26 species with the greatest concentration in southwestern United States and northern Mexico. Arizona should be considered as the center of diversity for the North American members with about 16 species, and the concentration decreases nearly exponentially with distance in all directions. The Intermountain Region, an area more than two-and-a-half times larger than Arizona, is home to 12 species with only three extending north of the region: *S. grossulariifolia* (Hook. & Arn.) Rydb., *S. munroana* (Douglas ex Lindl.) Spach ex A. Gray, and *S. coccinea* (Nutt.) Rydb. The latter two species extend to Canada and *S. coccinea* reaches the furthest east for the genus, extending into southern Manitoba, western Minnesota, western Iowa, Kansas, Oklahoma, and western Texas.

Although Kearney's (1935) revision of the North American species is now 67 years old, it has held up relatively well, which is remarkable for such a complex genus. His concepts of the species are still accepted, but perhaps reluctantly by many flora writers, in the absence of a modern assessment of the all the North American species. The only modifications come from the seven new taxa that have since been added, five of which are in the Intermountain Region. Welsh, in his study of the genus for the *Utah Flora* (Welsh et al. 1993), added four of them, *S. psoraloides* S.L. Welsh (1980), *S. janeae* (S.L. Welsh) S.L. Welsh (1980, 1998), *S. moorei* (S.L. Welsh) S.L. Welsh (Welsh 1980; Atwood & Welsh, in

press), and *S. grossulariifolia* var. *fumariensis* S.L. Welsh (Welsh & Atwood 2001); and a fifth from just south of the Utah border in northwestern Arizona, within the Intermountain Region, *S. gierischii* N.D. Atwood & S.L. Welsh (In press). Two other new additions are species from south of the region, *S. polychroma* La Duke (1985) and *S. reflexa* Fryxell, Valdés-Reyna & Villarreal (1991).

In my study of the genus for *Intermountain Flora* I have found the need to expand *S. caespitosa* M. E. Jones to accommodate a disjunct population from Railroad Valley in Nye County, Nevada, which can be distinguished as a separate variety. The species is closely related to *S. ambigua* A. Gray, differing from it most significantly in its shorter stature. The geographical ranges of the two varieties of *S. caespitosa* lie to the north of the northern limits of *S. ambigua* in Utah and eastern Nevada and to the east of its most northern limits in western Nevada and eastern California. A historical scenario for how the two varieties evolved is not implicit from their geographical setting. The two exist in similar desert-valley habitats separated by about 160 km of four major north-south oriented mountain ranges alternating with three relatively broad valleys. Their close similarity may be indicative of recent evolution from an element that migrated northward during a warmer Holocene episode, and their subsequent isolation has been long enough (in this interpretation) for some genetic drift to occur.

The two varieties of *S. caespitosa* can be distinguished from each other and from *S. ambigua* by the characters in the following key.

1. Plants 2.5–8 dm tall; calyx 8–16 mm long; staminal column (3.5–)4–5 mm long; schizocarp of 8–12(14) mericarps; seeds 1.5–2 mm long; southern half of Nevada and southwestern and northwestern Utah (but absent from the distributions of the *S. caespitosa* varieties), southward through southeastern California and western Arizona to Baja California _____ **S. ambigua**
1. Plants small, 0.3–2.5 dm tall; calyx 10–18 mm long; staminal column 3.5–9 mm long; schizocarp of 11–14 mericarps; seeds 1.9–2.3 mm long; east-central Nevada and central-western Utah _____ **S. caespitosa**
   2 Calyx 13 18 mm long; petals 16 23 mm long; staminal column 3.5 6 mm long; leaves thickish, grayish-green, densely pubescent, usually with stellate hairs overlapping and concealing or nearly concealing the surface; plants 0.3–1.5(1.7) dm tall; endemic to the western Utah desert in southwestern Millard County and adjacent northwestern Beaver County, at 1600–2000 m elevation _____ var. **caespitosa**
   2. Calyx 10–14 mm long; petals 15–20 mm long; staminal column 6 -9 mm long; mature leaves relatively thin, greenish, moderately pubescent with a considerable amount of surface exposed; plants 0.7–2.5 dm tall; endemic to Railroad Valley in northeastern Nye County, Nevada, at 1400–1600 m elevation _____ var. **williamsiae**

Sphaeralcea caespitosa M.E. Jones

Perennial herb, 0.3–1.6(–2.5) dm tall, arising from a woody, branched caudex surmounting a taproot; *herbage* grayish-green with a dense pubescence or pale greenish with a moderately dense pubescence, the hairs stellate, the rays of the hairs spreading in several different directions; *stems* few to several, ascending

or erect, unbranched; *leaves* all cauline, petiolate, the petioles 1–3.5(–7) cm long, the blades of the leaves at midstem larger than the lower, 1.5–4.5(–5) cm long and about as wide, deltate, ovate, or suborbicular, the base cordate, truncate, or broadly cuneate, the margin coarsely crenate or dentate-crenate, and sometimes obscurely 3-lobed, palmately veined, the veins prominent beneath and slightly channeled above; *stipules* filiform or linear; *inflorescence* few-flowered, the lower flowers racemose or solitary in leaf axils, the upper ones often in thyrsoid clusters, the rachis, pedicels, and calyces pubescent as below; *pedicels* 3.5–13 mm long, divaricately ascending, with stipular bracts at the base; *involucral bracts* filiform, pale brownish; *calyx* 10–18 mm long, the lobes lanceolate to ovate, acute, 2/3–3/4 of the calyx length; *petals* 15–23 mm long, the short claw ciliate, the blade obovate, reddish-orange (grenadine); *staminal column* 3.5–9 mm long, stellate pubescent, bearing anthers at the apex; *styles* with capitate stigmas; *schizocarp* of 11–14 mericarps forming a ring 7.5–8.5 mm in diam., each mericarp 2-seeded, 3–5.5 mm high, 2.2–4.6 mm wide, rounded dorsally and rounded to obtuse apically, coarsely reticulate on the sides of the indehiscent lower 1/3 and smooth-sided on the upper 2/3, pubescent on back; *seeds* 1.9–2.3 mm long, reniform, dark brown to black, minutely puberulent in patches.

Sphaeralcea caespitosa M.E. Jones var. **caespitosa** (**Fig. 1A–D**). *Sphaeralcea caespitosa* M.E. Jones, Contr. W. Bot. 12:4. 1908. TYPE: UTAH. BEAVER CO.: "Wa Wa ..., west of Frisco, at Dry Station, ... on very poor volcanic soil covering lava with a shallow coat, and in crevices of the rocks where there is a little soil," 6000 ft, Beaver Co., Utah, 25 Jun 1906, *M.E. Jones s.n.* (HOLOTYPE: POM!; ISOTYPES: NY!, US!)

Perennial herb 0.3–1.7 dm tall; *herbage* grayish-green, densely pubescent, the stellate hairs on mature leaves usually overlapping and concealing the leaf surface; *leaves* with petioles 1–3.3 (–5) cm long, the blades thick, 1.5–4.5 cm long and about as wide, deltate, ovate, or suborbicular, the base truncate to broadly cuneate, the margin coarsely crenate and sometimes obscurely 3-lobed; *calyx* 13–18 mm long; *petals* 16–23 mm long; *staminal column* 3.5–6 mm long; *mericarps* each 4.5–5.5 mm high and 3.2–4.6 mm wide, rounded apically.

Habitat.—Shallow, gravelly alluvial soils, mainly from the Sevy Dolomite Formation (Welsh 1993), and also from calcareous formations, often growing in shadscale, rabbitbrush, or matchweed associations, ranging from (1400) 1600 to 2000 m elevation.

Distribution.—West-central Utah in the valleys and foothills of southwestern Millard County and adjacent Beaver County, in and around the Desert Range Experimental Station (Fig. 2).

Phenology.—Flowering from late May to June, fruiting from mid June to August.

Sphaeralcea caespitosa M.E. Jones var. **williamsiae** N.H. Holmgren, var. nov. (**Fig. 1E–H**). TYPE: U.S.A. NEVADA. NYE CO.: Railroad Valley, just W of Lockes (Black

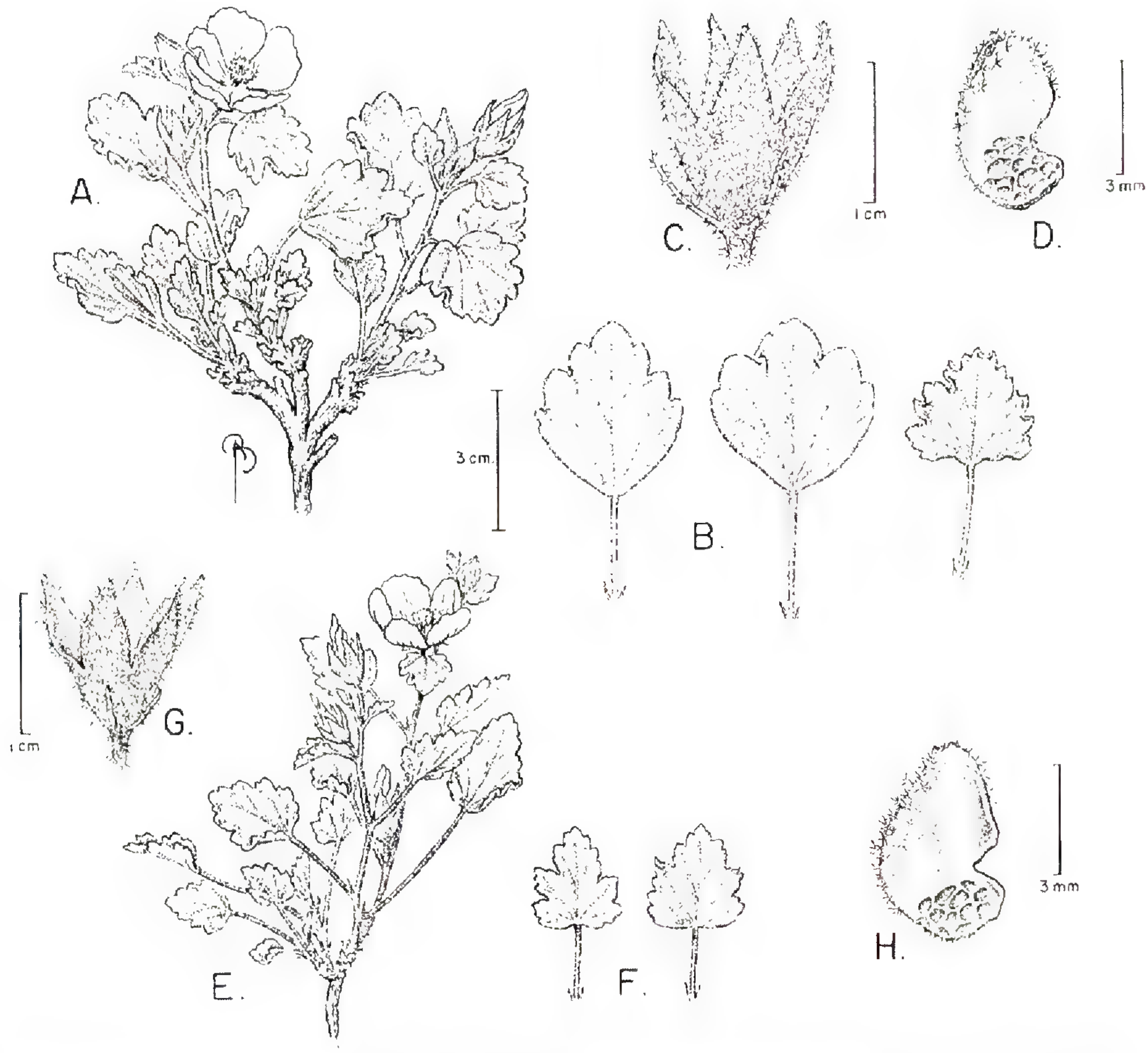


FIG. 1. A–D. *Sphaeralcea caespitosa* M.E. Jones var. *caespitosa*. A. Habit, B. Leaves (showing variation), C. Calyx and bractlets, D. Mericarp. E–H. *S. caespitosa* var. *williamsiae N.H.* Holmgren. E. Habit, F. Leaves, G. Calyx and bractlets, H. Mericarp. Illustrations by Bobbi Angell (all at NY), based on: A, C. *B. Maguire 20861*, B. (left to right) *R.C. Holmgren 265*, *B. Maguire 20876*, *S.L. Welsh & M. Chatterley 19530*, D. *R.C. Holmgren 265*, E, G. *S.L. Welsh 20579*, F, H. *K.H. Thorne & B.T. Welsh 957*.

Rock Station), 34.5 air km SW of Currant, 38° 33'13"N, 115° 46'34"W, T8N R55E S15, 4850 ft, 28 May 2001, *N.H. Holmgren & P.K. Holmgren 14322* (HOLOTYPE: NY!; ISOTYPES: BRY!, RENO!, UTC!).

A *Sphaeralcea caespitosa* var. *caespitosa* foliis tenuioribus, modice (non dense) pubescentibus atque calyce breviore, 10–14 mm (non 13–18 mm) longa differt.

Perennial herb 0.7–2.5 dm tall; *herbage* greenish, moderately pubescent; *leaves* with petioles 1.5–3.7(–7) cm long, the blades relatively thin, 1.5–3.5(–5) cm long, 1.5–3(–4) cm wide, deltate or ovate, the base cordate to truncate, the margin coarsely toothed or dentate-crenate and sometimes obscurely 3-lobed; *calyx* 10–14 mm long; *petals* 15–20 mm long; *staminal column* 6–9 mm long; *mericarps* 3–5.5 mm high, 2.2–3.5 mm wide, obtuse apically.

Habitat.—Shallow gravelly soils on alluvium and valley fill, in greasewood and shadscale communities, growing with *Artemisia spinescens*, *Atriplex*

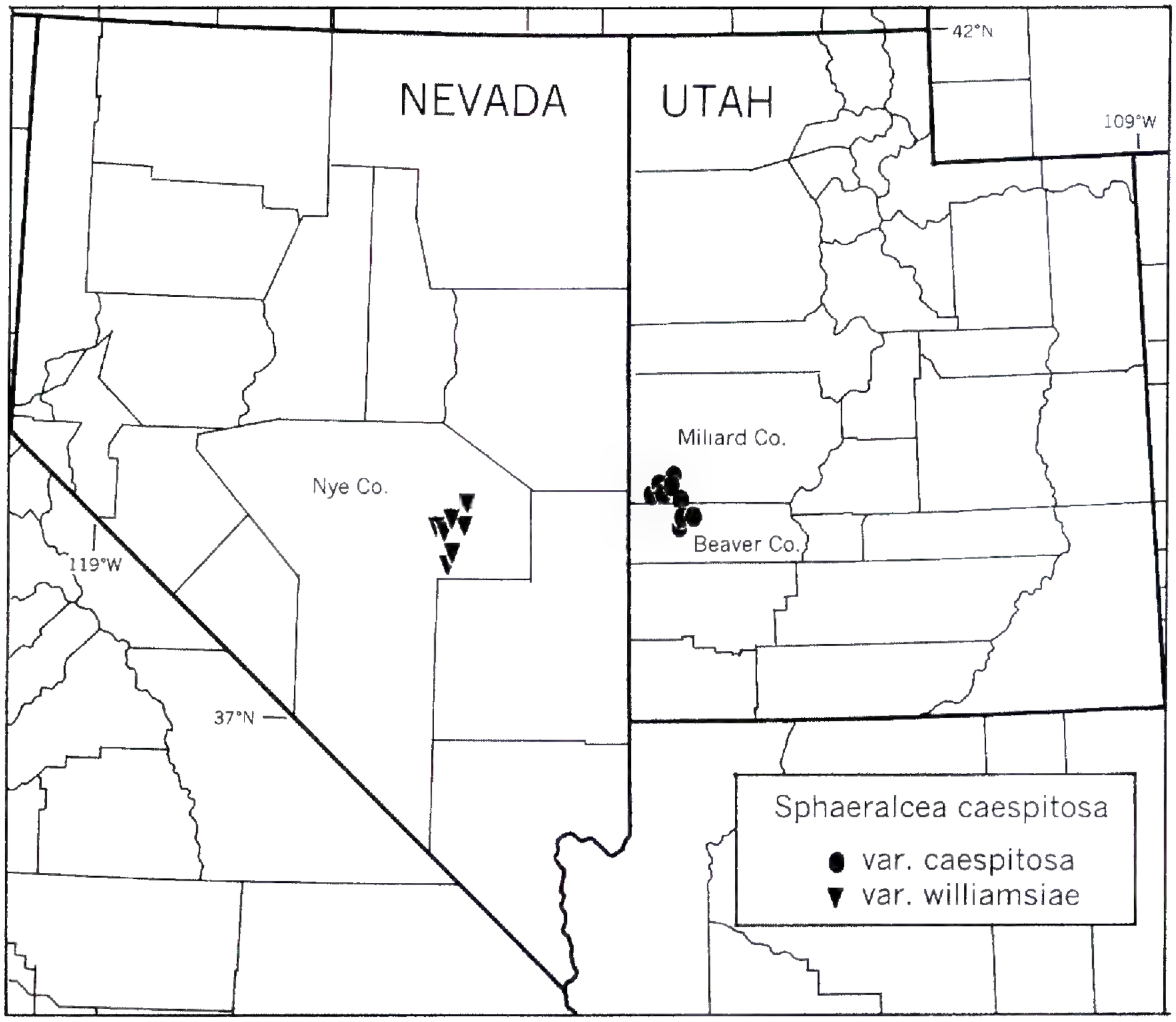


Fig. 2. Map of Nevada and Utah, showing the distributions of *Sphaeralcea caespitosa* var. *caespitosa* and *S. caespitosa* var. *williamsiae*.

confertifolia, *Ephedra viridis*, *Eriogonum shockleyi*, *Hilaria jamesii*, and *Kochia americana*, ranging in elevation from 1400 to 1600 m elevation.

Distribution.—Railroad Valley, northeastern Nye County, Nevada.

Phenology.—Flowering from May to June, fruiting from mid May to July.

Etymology.—It gives me special pleasure to name this lovely desert mallow in honor of Margaret Jensen Williams (1917–2000). *Sphaeralcea* ranked among the top of the many native Nevada genera for which Margaret had great fondness, and it is apparent from her many collections of this taxon that she regarded it as being particularly special. As seen by the tributes to her (Tiehm 2000), Margaret touched many lives.

Her sense of adventure lured her to many parts of the world, but she had a special bond with the Great Basin, especially Nevada. She always lived in Nevada, born in Gardnerville to ranchers, John and Wilhelmina Jensen. She earned her bachelor's degree at the University of Nevada, Reno, in chemistry and a master's degree in mathematics. She married her Chemistry Professor, Loring Williams, and together raised to two children. She was a math instructor at the

University until her appointment was terminated by bureaucratic nepotism rules. From 1959 until retirement in 1981, she taught 4th grade children in a Reno elementary school.

At home, in the early 1950s, she began to concentrate her enormous energy on gardening, at first growing the standard nursery-trade plants. As time passed, she became more and more sophisticated in her choice of garden subjects, especially alpine rock garden plants. It was not long before she was an active member of American, English, and Scottish rock garden societies. Her interests in the Nevada flora were spurred on by the writings in the society journals of Dwight Ripley and Rupert Barneby on their botanical excursions throughout the Great Basin. This deepening interest led her to take classes in plant taxonomy and field botany. At first she was just collecting seeds for exchange with rock garden friends in the U.S. and abroad. Then in the early 1970s, John Thomas Howell of the California Academy of Sciences inspired her to collect plant specimens.

In 1975 she founded the Northern Nevada Native Plant Society, which she presided over for several years, first as President, then as Executive Director. Her charisma, strong will, passion for plants, and contagious enthusiasm drew in a large and active membership, and the Society continues to thrive.

Her legacy lives on through the many research collections filed throughout many herbaria. Her collections filed at the New York Botanical Garden are especially valuable in our research on the *Intermountain Flora* (Cronquist et al. 1972–1997). She was involved in one way or another in collecting 12 specimens that are now types for species or varieties. Where she was not listed as the principal collector, it can be assumed that Margaret was the one who enabled the collection to be made. This attractive new variety joins *Polyctenium williamsiae* Rollins, *Eriogonum ovalifolium* var. *williamsiae* Reveal, and *Astragalus convallarius* var. *margaretae* Barneby as honorific eponyms.

On a personal note, my wife Pat and I will always treasure our many memories of Margaret. She supported our *Intermountain Flora* research in so many ways, from providing food and lodging in her home, transporting us to and from the airport and the RENO herbarium, to being a prompt and delightful correspondent.

PARATYPES: **Nevada. Nye Co.:** all in Railroad Valley: low volcanic hills 1 mi NE of Currant, 23 May 1982, *R.C. Barneby 17821* (NY!); 20 mi SW of Currant, 14 May 1941, *A. Eastwood & J.T. Howell 9426* (US!, UTC!); T8N R55E S21 (NW1/4), 4900 ft, 4 Jun 1991, *L. Grover s.n.* (RENO!); 50.2 km road distance S of Currant on the valley road, T5N R56E S3, 38° 19'18"N, 115° 39'38"W, 1495 m, 7 Jun 2000, *N.H. Holmgren & P.K. Holmgren 13840* (NY!); along U.S. Hwy 6, S side of the highway and at the SW edge of Black Rock Station (Lockes), T8N R55E S15, 38° 33'14"N, 115° 46'34"W, 1480 m, 7 Jun 2000, *N.H. Holmgren & P.K. Holmgren 13845* (BRY!, NY!, RENO!, UTC!); W side of Grant Range, ca. 1 road mi NE of Blue Eagle Spring along road to Currant, T8N R57E S1, 4800 ft, 12 May 1987, *T. Knight 1557* (NY!); 0.75 mi N of Lockes Ranch, 21 May 1945, *B. Maguire & A.H. Holmgren 25128* (NY!, UTC!); U.S. Hwy 6, ca. 20 mi S of Currant, 30 May 1986, *H.C. Stutz 94320* (BRY!); Cherry Creek Road, 1.6 mi to a small knoll N of the

road, T5N R56E S22, 5200 ft, 2 Jun 1980, *K.H. Thorne & B.T. Welsh 942* (BRY!); 1 mi NE of Currant, white knoll on N side of road, T10N R58E S9, 5250 ft, 3 Jun 1980, *K.H. Thorne & B.T. Welsh 957* (BRY!, NY!); ca. 22 mi SW of Currant, T8N R56E S1, 4800 ft, 1 Jul 1980, *B.T. Welsh, K.H. Thorne & S.L. Welsh 413* (BRY!, RENO!); 1 mi NE of Currant, T10N R58E S9 (NW/NW), 5300 ft, *Sarcobatus-Hilaria-Chrysothamnus* community, gravelly substrate, 23 May 1981, *S.L. Welsh 20579* (BRY!, NY!, RENO!); near Hwy 6, SW of Lockes, T8N R55E S21, 5300 ft, 20 Jun 1980, *M.J. Williams 80-164-1* (NY!, RENO!); ca. 1 mi NE of Currant, near Hwy 6, T10N R58E S4, 5300 ft, 29 Jun 1980, *M.J. Williams 80-166-1* (RENO!); 3.4 mi SW of Lockes, NW of Hwy 6, T8N R55E S19, 5300 ft, 9 May 1980, *M.J. Williams, S. Cochrane & A. Tiehm 80-8-3* (RENO!); 3.5 mi SW of Lockes on U.S. Hwy 6, then NW for 1.4 mi, T8N R54E S25, 5350 ft, 9 May 1980, *M.J. Williams, S. Cochrane & A. Tiehm 80-9-3* (RENO!); near U.S. Hwy 6, 0.4 mi NE of Currant, T10N R58E S4, 5150 ft, 26 May 1979, *M.J. Williams & J.S. Holland 79-54-7* (BRY!, RENO!); U.S. Hwy 6, near Mile 119, N of Currant, T10N R58E S4, 5300 ft, 23 May 1981, *M.J. Williams & A. Tiehm 81-18-1* (RENO!); S of Lockes, 1.6 mi S of U.S. Hwy 6, T8N R55E S27, 4770 ft, 23 May 1981, *M.J. Williams & A. Tiehm 81-19-7* (RENO!); ca. 3 mi SW of Lockes, T8N R55E S30, 5300 ft, 28 May 1978, *M.J. Williams & M. Williams 78-75-1* (RENO!, UTC!).

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THE PRESENT STATUS OF LEDERMANN'S APRIL RIVER LOCALITIES IN PAPUA NEW GUINEA

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ABSTRACT

The April River of East Sepik Province has received little attention since the German explorations of the early 1900s. However the social, logistical, and vegetation status of April environments present considerable opportunities for floristic discovery and documentation.

KEY WORDS: botanical survey, Kaiserin-Augusta Expedition, type localities, Papua New Guinea.

ABSTRACT (JAPANESE)

その生物史上のユニークな価値にもかかわらず、東セピック州のエイプリルリバー地域は、ドイツ人による最初の探検以来わずかにしか注目されてこなかった。 セピック川流域の、史学的に価値がある地域を調査するにあたっては、まず現状を知ることが重要である。そこで、最近の調査によって得られた、社会的状況、各種調査を行うための諸々の環境や植生に関する概要を発表する。本調査結果から当地域は植物学上の発見や新たな考証が行われる可能性が非常に高いということがうかがえる。

TOK IGO PAS (MELANESIAN TOK PISIN)

April wara long Is Sepik Provins i bin kisim liklik luksave tasol long taim bilong Geman long 1900 ikam inap long nau. Tasol, bikos long dispela hap, igat bikpela na gutpela bus, diwai, graun na tu laif bilong ol man na meri ino gat bikpela senis, wei dispela i bringim ol saveman na meri long lukluk moa long wok painim out igo insait long ol bus na diwai long hap bilong April wara.

INTRODUCTION

Of all the exploratory surveys conducted in New Guinea during the last 100 years, the German Kaiserin-Augusta Expedition of 1912–13 stands out as being particularly significant. During that expedition, botanist Carl Ledermann traveled extensively through the south Sepik basin with a multidisciplinary contingent, eventually collecting a total of 6,639 angiosperm numbers over a period of 18–19 months. Originating at an early point in the exploration of the Papuasian flora, a disproportionate number of Ledermann's collections were designated as type specimens. Many of his localities have never been revisited. The unfortunate circumstances of Ledermann's labors are an enormous obstacle to modern scientific inquiry, for the main German sets were destroyed in the

1943 fire at Berlin Herbarium, effectively erasing the primary basis for the identification of numerous plant species. Veldkamp et al. (1988) have provided an informative discussion of the relevant issues surrounding the loss of such a critical botanical corpus.

One of the most productive parts of the Kaiserin-Augusta itinerary was the series of collecting trips made by Ledermann to the April River (Aprilfluss). The Aprilfluss yielded a bountiful harvest of new species, many of which have unfortunately proven impossible to evaluate without the original collections. With modern assessment indicating the apparent existence of a zone of floristic endemism centered on the Hunstein-April region, it has become particularly desirable to revisit the classical localities and secure new material. Such efforts would enable neotypification of many species whose types were lost at Berlin (e.g., *Tapeinochilos hollrungii* K. Schum.; cf. Gideon 1998). Although a list of plants requiring new collections is reportedly being compiled (Veldkamp et al. 1988), no summaries are yet available.

The first serious reexamination of Ledermann's sites occurred in 1966, with the CSIRO-sponsored expedition to Mt Hunstein by R. Hoogland and L. Craven. In 1989 a multi-institutional survey returned to the Hunstein Range under the auspices of the National Geographic Society, obtaining 1,200 more botanical numbers (cf. Bakker 1994 for a general account). The first author, one of five botanists on that expedition, independently returned to the Hunstein summit in July–August 1990 and to the nearby Waskuk Hills in August 1994 and June 1995. Additional collections from the April-Sitipa drainages were made in September 1990, and from the April River serpentine zone on the south side of Mt Hunstein, in July 1995 (Fig. 1). The most recent trip to the subdistrict occurred in August 2001 (cf. Takeuchi & Golman 2002; Takeuchi & Renner 2002), from which much of the information in the following narrative has been taken.

THE SOCIAL ENVIRONMENT

The indigenous population of the Hunstein subdistrict is spread diffusely through the region in small clan-based villages. Ambunti is the largest settlement; with a district headquarters, tradestores, an aid post, two schools, several churches, and a grass airstrip. Further upriver and within the April catchment, the average settlements are much smaller, often consisting of a single extended family. At Garuka (Waskuk Hills) for example, the total adult population was exactly ten during the time of the 1995 survey. The larger villages like Baglam and Melawei have about a hundred inhabitants.

In the Sepik region, river-borne traffic is the major means of communication, trade, and transport. Most of the population are thus concentrated near the water. This also affords the people convenient access to fish and saksak (made from the starchy pith of the *Metroxylon* palm) which together comprise the bulk of the average villager's diet. A limited amount of subsistence slash and

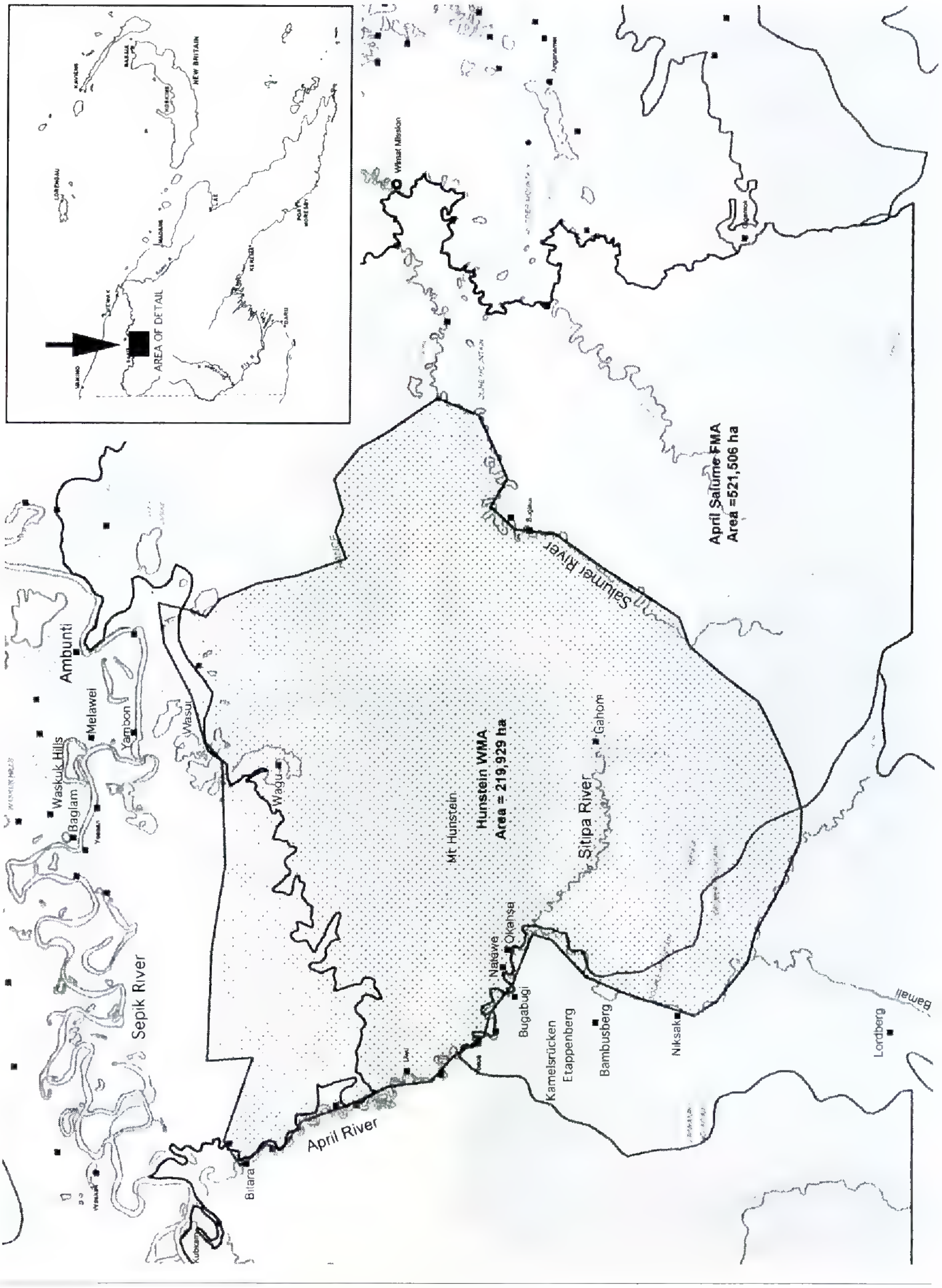


FIG. 1. Principal localities from the Hunstein subdistrict. Scale 1:500,000. The April Salumei FMA (Forest Management Agreement) Area is a proposed logging concession. Inset shows location of the Hunstein tract.

burn gardening provides dietary variety. Sweet potatoes, taro, bananas, and coconuts constitute the main crops, but plantings are generally not a principal source of village sustenance. For the most part, the April River populace are semi-nomadic hunter-gatherers.

Like the Sepik River, the April is a meandering silt-laden waterway which often changes course after severe floods. A recently introduced fish from South America (the pacu, erroneously identified as a piranha in the local media) has now entered the April drainage and is rapidly becoming the most commonly caught fish for consumption. Villagers report that the appearance and proliferation of the pacu have been accompanied by disappearance of many native fish species, particularly the endemic species of Sepik catfish (*Arius* spp., cf. Allen 1991). The pacu has reportedly been involved in several fatal attacks on bathers, but such anecdotal reports are often exaggerated and their veracity is uncertain.

Socioeconomic development in the April region is virtually nonexistent. The local economy is primarily subsistence in nature, and cash incomes are opportunistic. Money is occasionally earned from the sale of wood carvings, crocodile skins, birdwing butterflies, cacao, and from seasonal sources in the ecotourism niche market. Very recently, a lucrative trade has also emerged involving *Gyrinops ledermannii* Domke (Thymelaeaceae), with Indonesian buyers paying up to PNGK 800–1,000 (USD 265–335) for each kg of black wood. The arborescent species is endemic to the upper Sepik (Ding Hou 1960), and has become a significant income source for landowners due to consumer demand for the wood's pleasing fragrance, a development reminiscent of the sandalwood trade. Known as 'may-hasei' in the Parenemo language, *G. ledermannii* is common on the southwest side of Kamelsrücken and is also distributed on slopes facing the April River, particularly near Etappenberg (Takeuchi & Golman 2002). For many decades the species was known only by Ledermann's type gathering from the May River, but current indications suggest the tree probably ranges even into West Papua (ibid.).

In spite of income from such incidental sources, by Western standards the overall status of the people would be regarded as impoverished. Due to the inaccessibility of health services, mortality rates are high, especially from malaria and infections, and the local inhabitants frequently seek palliatives and remedies from whatever natural resources are at hand. Skin diseases like ringworm and scabies often affect entire villages.

April River culture is an improbable assortment of incongruities and apparent contradictions. Villagers have adopted western standards of dress, yet still retain their traditional lifestyle and customs. Many of the residents speak standard English, often freely intermixed with their tribal tokples (Baihenemo, Parenemo, Waskukil) in ad hoc combination. Although Christianity in its many variants is dominant throughout the region, belief in sorcery is closely interwoven through the Christian ethic. Sudden deaths are nearly always attributed

to black magic or to secret murders (sanguma) facilitated by plant poisons. 'Ukhop pok' (*Anodendron oblongifolium* Hemsl.; Apocynaceae) is the most commonly mentioned agent in sanguma killings. There is also a widespread conviction in the existence of spirits (masalai), believed to pervade all aspects of the natural world and which form an inseparable part of the villagers' metaphysical world-view.

The population growth rate for East Sepik Province is currently 2.9% per annum, a relatively high figure, but below the Mamose[1] regional average of 3.3% (National Statistical Office 2001). Most of the provincial population is concentrated in the built-up areas near the coast, and the interior sections such as April River consist primarily of wilderness habitat. Due to the low population densities in this part of PNG, there are no subsistence-based threats to the environment. However, because the entire region along the April-Salumei is one of PNG's most economically depressed areas, landowners are understandably attracted by the inducements offered by logging and mining interests. A major portion of the district has been proposed as a timber concessional area under the Forest Management Agreement protocols (cf. Papua New Guinea Forest Authority 1998). Reconciling the conflicting desire for socioeconomic development on one hand, with conservation concerns on the other, will be a major challenge for community planners. Many of the relevant issues are presently being addressed by the World Wildlife Fund (WWF), through the establishment of an ICAD (Integrated Conservation and Development) program in the Hunstein area and the related demarcation of a Wildlife Management Area (WMA; Fig. 1). The Village Development Trust is also contemplating start-up of a comparable program in the Bugabugi territory and the Waskuk Hills (Aung & Kisokau pers. comm.). In the past, investigators moved freely throughout the area, subject only to approval from the customary landowners. With the recent and impending developments, this is likely to change. Intervention by nongovernment organizations (NGOs) invariably results in new requirements which can complicate scientific access and research. The complications are offset however, by the real and perceived benefits which NGO association can deliver to affected communities.

Land ownership and the subsequent control of access to forest resources are traditional and patrilineal. Nearly all territories fall under clan jurisdiction, so discretion must be exercised during plant collecting in order not to trespass on land unapproved for gathering. A gratuity paid to the landowner(s) is often necessary to ensure approval for plant collecting.

THE LOGISTICAL ENVIRONMENT

In contrast to the many obstacles which confronted the first explorers, access to the upper Sepik has improved to such an extent that the region is now a major

[1]Mamose is the administrative unit composed of West Sepik, East Sepik, Madang, and Morobe Provinces.

ecotourist destination. Until recently, ocean-going tourist vessels made regularly-scheduled luxury cruises as far upstream as Ambunti. Although travelers can still expect numerous delays arising from conditions endemic to developing countries, entry to the April basin has been considerably eased by the new airfields at Bugabugi and Niksak.[2] Both airfields are small grass strips maintained by New Tribes Mission, and can accept only the single-engine Cessna 206, with maximum lift capacity of 5 passengers or 400 kg. Otherwise access can also be made via the airfield at Ambunti, which can accommodate larger twin-engined Islanders capable of carrying 19 passengers or 1,600 kgs of freight (Missionary Air Fellowship). From Ambunti a visitor would ordinarily proceed to the April River with dugout canoes powered by Yamaha outboard motors (15, 30, or 40 hp motors are the usual ratings). The fuel consumption of a 30 hp motor on a roundtrip between Ambunti and Bugabugi will be at least 140 liters. In the upper Sepik, fuel is problematic, being either unavailable or prohibitively expensive.

The buttress ridges in the vicinity of Bugabugi (Pinape, Natawe, and Okahsa), lead directly to Mt Hunstein and represent the easiest path to the top. In 1989, the National Geographic expedition approached the summit from the north, which is actually the longest and most logistically difficult land route. Ledermann's two trips to Hunsteinspitze had come the same way, from Ambunti and through Wasui-Wagu Lagoon (cf. Steenis-Kruseman 1950: 317–18). The entry via Wagu was similarly taken by Hoogland and Craven in 1966 (Craven pers. comm.). The quickest access however, is to follow the south-descending ridges from the April River, preferably starting at Natawe (Fig. 2). With the newly operational airfield at Bugabugi, the latter route can now be used to reach the Hunstein crestline within two days of departure from the provincial seat at Wewak. The south-side approach provides the added advantage of passage through unexplored ultrabasic habitats.

Field conditions in the April drainage are onerous. The heat and humidity are stultifying during dry periods and the wet season is accompanied by torrential downpours after which the river is hazardous at many places along its course. Prolonged visits are a health risk. The physical difficulties are aggravated by the absence of any service infrastructure throughout the region, except for basic facilities at missionary stations. Over much of the year the mosquito and leech populations are exceptionally troublesome even by the standards of an alluvial tropical environment. When it is not raining, horseflies are annoyingly plentiful, especially in areas where pigs are present in the forest. Poisonous snakes have been responsible for a substantial number of deaths in the village communities.

[2] Niksak is 18 km north of Lordberg, one of the enigmatic localities from Ledermann's Aprilfluss itinerary on the Bamali tributary, and would be the only cost-effective point of access in any future attempt at revisiting the latter site.



FIG. 2. Photographic montage from a vantage point at Natawe. A: Okahsa, at the base of foothills of the Hunstein Range. Foreground: main streamcourse of the April River. B: Etappenberg (on slopes behind the ridgeline). C: the distinctive double peaks of Kamelsrücken (the high peak is the Mt Samsai of modern maps). Ledermann's Bambusberg and Lordberg are behind the crestline on the horizon, in a direction ca. halfway between Okahsa and Etappenberg.

THE FLORISTIC ENVIRONMENT

The vegetation along the April River consists of three principal formations. The swamp forest (with several facies including levee forest, meander scrolls, swales, etc.) is the dominant community on the flood plain. Typically waterlogged or inundated during rainy periods, the swampy habitat is dominated by *Metroxylon sagu* Rottb., *Campnosperma brevipetiolata* Volk., or herbaceous vegetation (especially *Saccharum robustum* Brandes & Jeswiet ex Grassl; cf. Warner & Grassl 1958). On better drained alluvium the forest is more structurally developed, giving rise to a second association with many macrophyllous taxa (e.g., *Artocarpus communis* J.R. & G. Forst., *Caryota rumphiana* Mart., *Pangium edule* Reinw., *Sterculia macrophylla* Vent., and *Nauclea orientalis* L.). These communities have characteristically high proportions of robust climbers along the edges, particularly *Calamus*, *Korthalsia*, and to a lesser extent *Freycinetia*, and the interior sections often support a luxuriant shrub layer. On the Hammermaster and Saunders (1995a, b) forest classification system, the riverine vegetation is described as an open forest on low elevation plains and fans, or as swamp woodland (forest code 'Po' and 'Ws' on overlays SB 54-4 and SB 54-3 to the Ambunti and Mianmin 1:250,000 Australian Survey Corps topographic sheets). Paijmans (1976) provides a concise overview of the vegetation in such environments.

At several places along its course, the April River skirts the base of serpentine/ultramafic foothills and there is a sharp floristic break as the swamp and alluvial associations are replaced by foothill forest. The contrasting features of the forest facies on ultramafics are: 1) a pronounced reduction in climbers (e.g., *Calamus* is virtually absent), 2) a more varied canopy structure, including a noticeable reduction in large-leaved taxa, 3) increased floristic richness, most apparent in an understory which is not subject to the periodic flooding characteristic of the alluvial flats, 4) a 'clean' visual aspect to the community, with good visibility through the forest because of the absence of climbers and comparative lack of epiphytic growth on tree boles, 5) a very obvious change in taxonomic composition, many taxa being common on the ultramafic slopes but absent from immediately adjacent alluvial forest. When observed from the outside, the ultramafic community is similar in physiognomy and structure to a montane forest, except for the paucity of epiphytes. Based on air photo interpretation, the April foothill zone is a medium-crowned low altitude upland forest (code 'Hm' in Hammermaster & Saunders 1995a), a vegetation type which is probably Papuasia's richest forest structural category (Louman & Nicholls 1995). Although an unpublished report (Sohmer et al. 1991) provides a brief botanical description of the Hunstein Range, there is still nothing in the way of a comprehensive account for the April basin.

The forest on ultramafic foothills is easily accessed near Bugabugi[3] (Pinape, Natawe and Okahsa: in sequential order upriver), though the best section is situ-

ated at the base of the Hunstein Range between Gahom and Okahsa, close to the junction of the April and Sitipa rivers (Figs. 3, 4). A conspicuous feature of the hill community is the presence of *Agathis labillardieri* Warb. emergents on the ridge buttresses and crestlines. *Agathis* attains heights exceeding 50 m, and the April provenances can be seen from the river towering over the surrounding canopy. The populations are of commercial significance, so not unexpectedly, has attracted the attention of logging and ecoforestry operators. Due to the steep and rocky slopes, Bugabugi villagers do not establish subsistence gardens in the foothill habitat, and the slopes are thus remarkably free of human disturbance. However, many understories near the river are being disrupted by domestic and wild pigs. Large seral gaps are also scattered through the forest as a result of natural disturbances from landslides, lightning strikes, and windthrows. For a lowland environment, the frequency of lightning-induced gaps is surprisingly high, an indication of the intense electrical and thunderstorm activity in the Hunstein Range.

During the 1998 el Niño disturbance, the Hunstein subdistrict and the entire basin to the south was severely affected by drought. The Sepik became dry in many sections even though it represents the largest catchment system among PNG's rivers. At Yambon gate, the Sepik current normally accelerates through a narrow channel renowned for treacherous whirlpools (cf. Townsend 1968), yet villagers were able to walk across to the opposite bank during the 1998 drought. In spite of such conditions, and unlike many other forested sites in PNG, April River environments did not experience any fires during the last disturbance. However a large tract downstream of Bitara has been recently flattened by cyclonic-force winds, and the forest canopy in a swath ca. 1 km wide completely removed. From current events, it is apparent that vegetational histories in this basin are at least partly determined by catastrophic events (cf. Johns 1986).

Since the time of its initial exploration, the Hunstein subdistrict has been judged a particularly significant hotspot for diversification and endemism. The biodiversity status of the area has assumed legendary proportions, even though the perception of unusual richness can be regarded as a natural outcome of physical and historical considerations.

The geological complexity of the April-Hunstein territory is a major contributing factor in the diversification of its flora. Alluvium, colluvium, sandstone, shale, mafic/ultramafic metamorphics, igneous, clay, and coralline lime

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[3]Bugabugi is 11–12 km NE of the classical locality of Etappenberg, the latter representing one of Ledermann's collection sites on Kamelsrucken (Came Back; on some maps now as Samsai Mt) of the Aprilfluss itinerary. Kamelsrücken is known to the Bugabugi people as Oopay. There is some inconsistency in the use of the location name 'Samsai' or 'Samsait', because the name is applied by Wagu and some Bugabugi villagers to Mt. Hunstein (Hunsteinspitze), and is used with that reference, for example, in the Hoogland and Craven collections from 1966.



FIG. 3. Exterior view of the forest at Okahsa. Foreground: April River. The serpentine zone encompassing Okahsa and the south-descending foothills have never been properly explored. Although many plot studies and botanical surveys have been concluded in PNG during the last ten years, there is still not even one floristic account for communities on ultrabasics.

stone substrates occur throughout the area in patches of varying size (Davies & Hutchison 1980a, b). There is thus a highly fragmented pattern of contrasting substrates over the terrain, reflecting the manifold geological origins of the present territory and capable of supporting specialist taxa in a complex mosaic. Superimposed on the foundation of edaphic environments is an exceptional annual rainfall estimated at 7,000–9,000 mm (ibid.). High rainfalls are directly related to floristic diversification (Gentry 1988) so perhumid conditions in the April basin have probably played a major role in the development of a speciose flora. When the dynamic fragmentation of the ecosystem is then considered, over presently observable scales ranging from lightning strikes to catastrophic storms, it is not difficult to imagine how a great number of plant species can be accommodated in side by side fashion over relatively small distances. The heterogeneity of April habitats also needs to be viewed in terms of the evidence regarding correlations between plant distributions and phases of tectonic accretion (cf. Welzen 1997). Part of the district's reputation as a zone of floristic peculiarity (Veldkamp et al. 1988) is due to its easternmost position in the terrane complex which constructed most of northern West Papua (cf. Pigram & Davies 1987). The Hunstein flora is probably best understood as an extension of the West Papuan flora. During the time of Davies and Hutchison (1980b) the Hunstein-April-Salumei petrology was already known to extend



FIG. 4. Interior perspective of the ultramafic forest at Okahsa. Small trees with depauperate crowns are typical of such substrates. Stem densities are high.

westwards rather than eastwards. If the division between PNG and West Papua were to be based on geophysical rather than political criteria, the border would be at April-Salumei rather than Sandaun.

Based on the relationship to tectonics, future distributional records of Hunstein/April endemics will occur to the west, as the Papuan affinity clarifies through further exploration of West New Guinea (Indonesian West Papua). At present, the Indonesian side is even more inadequately surveyed than PNG, and the historical disparity in documentation between the two halves is partly responsible for the perception of unusually high endemism in the Hunstein/April region. The newly discerned disjunction of *Myrmephytum* in the Vogelkop and Hunstein areas (Jebb pers. comm.), of *Faika* in West Papua and the April River (Takeuchi & Renner 2002), and the probable occurrence of *Gyrinops ledermannii* in Jayapura (Takeuchi & Golman 2002) are suggestive of the phytogeographic connections, and of the effect which historical patterns in floristic documentation have on assumed distributions (Figs. 5, 6).

DISCUSSION

Nearly 90 years after the Kaiserin Augusta Expedition, many of the environments along the April River are still unexplored. The localities at the Expedition's farthest penetration into the south basin, near the headwaters of the Bamali tributary, have never been revisited. Of these, Lordberg is probably the most intriguing, but any effort focused on the Divide south of Niksak will undoubtedly reap huge rewards. The recent discoveries from Bugabugi exemplify the possibilities. Although the 6,639 collections taken by Ledermann represent an unprecedented achievement for his time, even a personal effort of that intensity cannot provide the desired level of sampling saturation for such a floristically rich region. A collections program delivering at least 10,000 new numbers is much needed.

The factors militating in favor of future survey success in the April drainage can be recanted: 1) forest communities in the region are in an exceptional state of preservation, 2) traditional lifestyles and ethnobotanical competences are still retained by local villagers, who are thus a valuable source of the folklore knowledge being rapidly lost in other districts, 3) improved site access to the interior basin will enable adoption of cost-effective logistical schedules, 4) research conducted by various investigators since 1989, has created local awareness of the work done by scientists, which will facilitate future inventories.

No collections effort conducted under normal constraints, can achieve 100% coverage of a targeted flora. There is always something which will be overlooked on account of rarity, phenology, localized distribution, logistical limitations, etc. Even the collections obtained by Ledermann during his Sepik travels are not such a superlative effort as may appear at first glance. The 6,600+ numbers from the Kaiserin Augusta survey amount to approximately 400 numbers per



FIG. 5. *Faika villosa* (Kaneh. & Hatus.) Philipson, in the forest understory at Okahsa (det. by S.S. Renner).



FIG. 6. As for figure 5, showing leaves, branchlet, and fruits (leaf blades ca. 10 cm wide). The April River *Faika* occurrences are a PNG generic record in Monimiaceae (cf. Takeuchi & Renner 2002).

month on a time-averaged basis (excluding Ledermann's 2 months of inactivity due to sickness). By the productivity standards of contemporary collectors working under rapid assessment protocols, this is a below-average result. The significance of the Ledermann collections are another matter altogether however. And in fairness, the logistical environment of his time was undoubtedly much more limiting than now. The difficulties of prolonged expeditionary schedules also should not be underestimated. Anyone with knowledge of Papuasian forest environments can appreciate the hardships in being exposed to tropical conditions for the duration which Ledermann was subjected to.

Some indication of the spottiness of Ledermann's sampling coverage can be gauged by results from the 1966 and 1989 expeditions to Mt. Hunstein. Several scores of new taxa have been described from the later visits, so clearly the original effort was not very comprehensive. To what extent does that situation apply to even more remote sites, such as Niksak-Lordberg? On the basis of accumulating evidence showing that the richest floristic interval in Papuasia is the premontane zone (Takeuchi & Golman 2001), the best environments within the April region are probably the ones at the Central Divide, and these have never been seen since Ledermann's time. The diversity potential of this flora has yet to be plumbed.

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BIOSYSTEMATIC ANALYSIS OF THE *THELESPERMA SUBNUDUM* COMPLEX (ASTERACEAE)

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ABSTRACT

Chromosome studies and phylogenetic analyses of morphology, allozymes, and nrDNA-*ITS* sequence data were used to resolve taxonomic relationships in the *Thelesperma subnudum* complex. Of special interest is the placement of three globally rare members of the complex: *Thelesperma caespitosum*, *T. pubescens*, and *T. subnudum* var. *alpinum*. The first two rare taxa yield only diploid (*n*=12) chromosome counts; *T. subnudum* var. *alpinum* is consistently tetraploid (*n*=24). *Thelesperma subnudum* var. *subnudum* exhibits both diploid (*n*=12) and tetraploid (*n*=24) populations. Phylogenetic analyses of individual data sets strongly support (bootstrap 88%–99%) *T. subnudum* var. *alpinum* as being more closely related to *T. pubescens* and *T. caespitosum* than to *T. subnudum* var. *subnudum*. Combined analyses give the strongest support (bootstrap 100%) for the clade of *T. pubescens*, *T. caespitosum*, and *T. subnudum* var. *alpinum*. Preliminary evidence suggests that *T. subnudum* var. *alpinum* may be an allotetraploid resulting from hybridization between *T. pubescens* and *T. subnudum*. Based on the available evidence, we propose the following nomenclatural changes: ***Thelesperma pubescens*** Dorn var. ***caespitosum*** (Dorn) C.J. Hansen, stat. nov., and ***Thelesperma windhamii*** C.J. Hansen, nom. et stat. nov.

KEY WORDS: *Thelesperma*, Asteraceae, nrDNA-*ITS* sequences, phylogenetics, and systematics.

RESUMEN

Se han usado estudios cromosómicos y análisis filogenéticos de datos morfológicos, alozimas y de secuencias de nrDNA-ITS para tratar de resolver las relaciones taxonómicas dentro del complejo *Thelesperma subnudum*. De especial interés es la posición taxonómica de los tres miembros del complejo: *Thelesperma caespitosum*, *T. pubescens* y *T. subnudum* var. *alpinum*, considerados globalmente raros. Los dos primeros taxa mostraron solamente poblaciones diploides (*n* = 12), mientras que *T. subnudum* var. *alpinum* se mostró constantemente como tetraploide (*n* = 24). *Thelesperma subnudum* var *subnudum* mostró tanto poblaciones diploides (*n* – 12) como tetraploides (*n* = 24). Los resultados del análisis filogenético de diferentes tipos de datos soportan más fuertemente (bootstrap 88%–99%) el agrupamiento de *T. subnudum* var. *alpinum* con *T. caespitosum* y *T. pubescens*, que su agrupamiento con *T. subnudum* var. *subnudum*. Los análisis combinados mostraron el máximo soporte (bootstrap 100%) para el clado compuesto por *T. subnudum* var. *alpinum*, *T. caespitosum* y *T. pubescens*. Evidencias preliminares sugieren que *T. subnudum* var. *alpinum* podría ser un alotetraploide resultante de la hibridación entre *T. subnudum* y *T. pubescens*. De acuerdo con la evidencia disponible proponemos los siguientes cambios nomenclaturales: ***Thelesperma pubescens*** Dorn var. ***caespitosum*** (Dorn) C.J. Hansen, stat. nov. y ***Thelesperma windhamii*** C.J. Hansen, nom. et stat. nov.

PALABRAS CLAVE: *Thelesperma*, Asteraceae, nrDNA-*ITS* secuenciación, filogenética y sistemática.

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Thelesperma Lessing (Asteraceae: Heliantheae, Coreopsidinae) comprises about 15 species, mostly herbaceous perennials (annuals and subshrubs rare), native to south-central and western North America and warm-temperate South America (Melchert 1963; Bremer 1994a). The genus is thought to be monophyletic based on shared characters such as strongly dimorphic involucral bracts, scarious-margined inner involucral bracts that are connate from 1/5 to 1/2 their lengths, opposite leaves, and pappi that are absent or composed of hispid or serrulate awns (Bremer 1994a). Previous taxonomic studies of *Thelesperma* have focused on morphology (Shinners 1950a, b; Alexander 1955) and cytology (Melchert 1963; Greer 1997; Greer & Powell 1999) and were not explicitly phylogenetic. Nevertheless, past work on the genus has identified some species groups that may be monophyletic. One of these is the *Thelesperma subnudum* complex, which is restricted to the Colorado Plateau and areas adjacent to the Rocky Mountains in western North America (Fig. 1). This group includes five commonly accepted taxa: *T. subnudum* A. Gray var. *subnudum*, *T. subnudum* A. Gray var. *alpinum* S.L. Welsh, *T. pubescens* Dorn, *T. caespitosum* Dorn and *T. marginatum* Rydb. Features used to distinguish members of the *T. subnudum* complex are given in Table 1.

Delimitation of taxa within the *Thelesperma subnudum* complex has varied, and at least three classifications have appeared (Table 2). Dorn (1990), who discovered and named *T. pubescens* and *T. caespitosum*, recognized each as distinct species. He treated *T. marginatum* as a separate species and accepted *alpinum* as a variety of *T. subnudum*. In the 2nd edition of *A Utah Flora*, Welsh et al. (1993) classified both *T. caespitosum* and *T. subnudum* var. *alpinum* as varieties of *T. subnudum*; *T. marginatum* and *T. pubescens* were not treated because the former is not known from Utah and discovery of the latter in Utah postdates publication of the flora. Cronquist et al. (1994) recognized only *T. subnudum* and *T. pubescens* at the species level; *T. caespitosum* and *T. subnudum* var. *alpinum* were included within *T. pubescens*, and *T. marginatum* was treated as a variety of *T. subnudum*.

These divergent classifications result from differing interpretations of the available morphological and cytological information. Additional genetic data (e.g., allozyme and DNA) are needed to allow an informed choice between competing taxonomies. The need to pursue these studies has been heightened recently by conservation concerns. *Thelesperma pubescens*, *T. caespitosum*, and *T. subnudum* var. *alpinum* are rare taxa restricted to a few localized populations (Fig. 1). All three have been listed as potentially endangered (category 2) by the U.S. Fish and Wildlife Service (U.S. Dept. of Interior 1985, 1993). The accumulation of genetic data is an important step in determining their eligibility for federal protection under the Endangered Species Act.

Our objectives in this study are threefold: 1) to develop baseline genetic data for members of the *Thelesperma subnudum* complex, 2) to analyze the data in

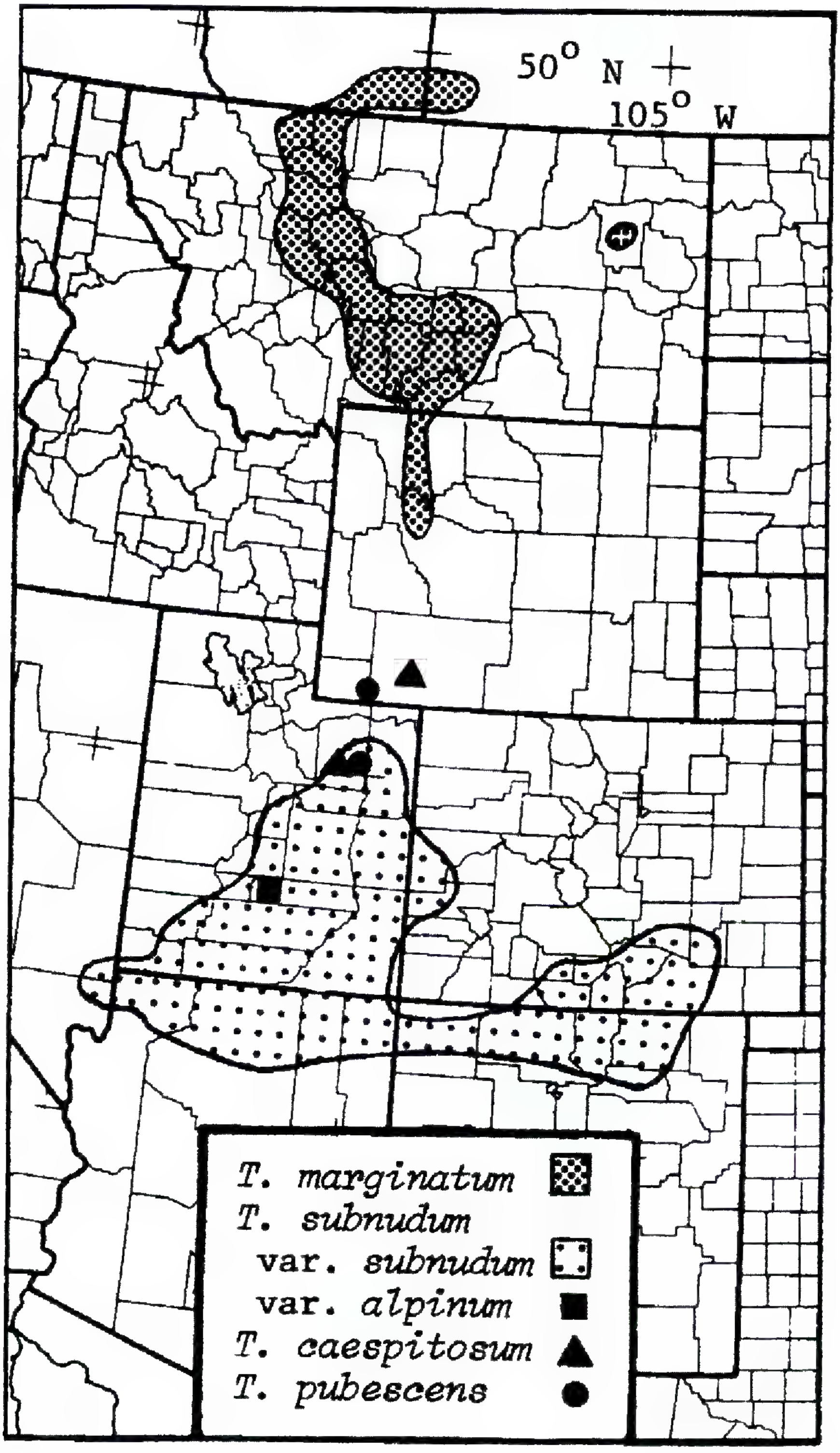


FIG. 1. Distribution of taxa in the *Thelesperma subnudum* complex. (Modified from Dorn 1990).

TABLE 1. Selected morphological, ecological, and distributional features distinguishing taxa of the *Thelesperma subnudum* complex. Modified from Dorn 1990.

Taxa	Leaf segments	Pubescence	Heads	Rootstock	Habitat	Elevation (m)
T. subnudum	long, broad	none	1-several, radiate (rarely) discoid	somewhat creeping	common, sandy soils	1050–2310
T. subnudum var. *alpinum*	short, narrow	lower stems & leaves	1(2), discoid	somewhat creeping, branched caudex	specialized, Carmel Form. Navajo Sandstone	1830–2680
T. marginatum	long, broad	none	1-several, discoid	somewhat creeping	common, sandy out wash	2130–2835
T. pubescens	short, narrow	leaves	1(2), discoid	branched caudex	specialized, weathered Bisnop conglomerate	2430–2715
T. caespitosum	short, narrow	petioles (lower blade)	1(2), discoid	branched caudex	specialized, whitish shale	1220–2680

concert with morphology to produce an explicit phylogenetic hypothesis for these taxa, and 3) to compare that hypothesis to existing classifications and propose any desirable taxonomic changes. Through this process, we hope to shed light on the relationships and possible origin of *T. subnudum* var. *alpinum*, the rarest and most enigmatic member of the group.

MATERIAL AND METHODS

Determination of Chromosome Numbers/Ploidy Level

Ploidy levels were determined for all taxa in the *T. subnudum* complex using a combination of chromosome counts and analyses of allozyme banding patterns. For chromosomal observations, capitula (in bud) were obtained from field populations and fixed in Farmer's solution (3 parts ethanol:1 part glacial acetic acid). Chromosome counts were made from meiotic figures obtained using standard squash techniques and acetocarmine staining (Turner & Johnston 1961; Strother 1972). Preparations were examined under phase contrast on a Zeiss Axioplan2 Microscope. Images of chromosome squashes were saved electronically using Zeiss Image® software from Carl Zeiss, Inc.

In populations for which flower buds were unavailable, ploidy level was determined by careful examination of allozyme banding intensities across a variety of enzymes (Danzmann & Bogart 1982a; Dessauer & Cole 1984; Pryer & Haufler 1993). Because allozyme markers are additive, codominant, and

TABLE 2. Previous taxonomic treatments of *Thelesperma subnudum* and allied taxa.

Dorn (1990)	Welsh et al. (1993)	Cronquist et al. (1994)
T. subnudum var. *subnudum*	*T. subnudum* var. *subnudum*	*T. subnudum* var. *subnudum*
T. subnudum var. *alpinum*	*T. subnudum* var. *alpinum*	*T. pubescens*
T. pubescens	Not treated	*T. pubescens*
T. caespitosum	*T. subnudum* var. *caespitosum*	*T. pubescens*
T. marginatum	Not treated	*T. subnudum* var. *marginatum*

inherited in a Mendelian fashion, the expressions of alleles at various ploidy levels are expected to be proportional to their gene dosages. In our study, chromosomally documented diploids in *Thelesperma* always showed balanced band patterns at heterozygous loci. If a heterozygote showed unequal band intensities of 3:1 (in a monomeric enzyme) or 9:4:1 (in a dimeric enzyme), the particular individual always proved to be tetraploid (the only type of polyploid encountered during our study). Thus, chromosomally unknown populations could be assigned to a specific ploidy level based on the presence or absence of unbalanced heterozygous allozyme patterns.

Morphological Data

Our coding of morphological character states is based on observation of approximately 300 herbarium sheets from ASC, BRY, GH, MONTU, NMU, NY, RM, UT, and UTC (herbarium designators follow Holmgren et al. 1990). These data were supplemented by information obtained from Melchert (1963), Welsh (1983), Dorn (1983, 1990), Jansen et al. (1991), Ryding & Bremer (1992), Welsh et al. (1993), Cronquist et al. (1994), and Karis & Ryding (1994). Ingroup taxa included *T. subnudum* var. *subnudum*, *T. subnudum* var. *alpinum*, *T. pubescens*, *T. caespitosum*, and *T. marginatum*, plus the related species *T. filifolium* (Hook.) A. Gray, *T. longipes* A. Gray, and *T. megapotamicum* (Spreng.) Kuntze. *Bidens* has been identified as a possible sister genus to *Thelesperma* (Ryding & Bremer 1992) and two species of that diverse genus, *B. cernua* L. and *B. frondosa* L., were chosen as outgroup taxa. A total of 16 characters (14 binary and 2 multi-state) was included in the morphological analysis (Tables 3, 4).

nr DNA-ITS Sequence Data

Samples used in the DNA study are identified by their GenBank accession numbers in Table 5. *ITS* sequences for the outgroups *Bidens cernua* and *B. frondosa* were obtained from GenBank; voucher data for these collections can be found in Ganders et al. (2000). The *ITS* sequences for all *Thelesperma* taxa were obtained directly by extracting total DNA from the leaf tissue of dried specimens using a basic CTAB extraction protocol (Hillis et al. 1996). Two different individuals from each taxon were sampled in order to check for intraspecific differences. The *ITS*-1 & 2 and 5.8S regions were amplified using the polymerase chain

TABLE 3. Morphological characters and character states used in phylogenetic analysis. All characters treated as unordered.

1. Herbs (0); subshrubs (1).
2. Perennial (0); annual (1).
3. Plants with taproots, sometimes creeping (0); fibrous roots (1); rhizomes (2).
4. Plants without a branching caudex (0); plants with a branching caudex (1).
5. Plants not marcescent basally (0); plants marcescent basally (1).
6. Leaves cauline (0); leaves basal, much reduced distally (1).
7. Leaves simple, entire or dentate only (0); leaves pinnately or ternately lobed (1).
8. Leaves glabrous (0); only leaf petioles or leaf margins pubescent (1); leaves pubescent throughout (2).
9. Inner involucral bracts essentially free (0); inner involucral bracts connate 1/5 or more (1).
10. Inner involucral bracts without scarious margins (0); inner involucral bracts with scarious margins (1).
11. Capitula with ray flowers (0); capitula without ray flowers (1).
12. Disc florets equally lobed (0); disc florets unequally lobed (1).
13. Cypselae straight (0); cypselae incurved (1).
14. Cypselae pubescent throughout (0); cypselae glabrous or apically pubescent only (1).
15. Pappus present (0); pappus absent (1).
16. Stems pubescent (0); stems glabrous (1).

TABLE 4. Morphological data matrix for taxa in *Bidens* and *Thelesperma*. Characters as listed in Table 3. Variable characters are coded as 'v'.

Taxa	Character Number 12345 67891 11111 1 0 12345 6
Bidens cernua	01100 00000 v0000 0
Bidens frondosa	01100 01000 10000 0
Thelesperma caespitosum	00011 11111 10111 1
Thelesperma filifolium	01000 01011 01110 1
Thelesperma longipes	10000 11011 10110 1
Thelesperma marginatum	00000 11011 10110 1
Thelesperma megapotamicum	00200 01011 11110 1
Thelesperma pubescens	00011 11211 10111 1
Thelesperma subnudum	00000 11011 v0110 1
Thelesperma subnudum var. *alpinum*	00011 11011 10110 1

reaction (PCR) and two primers in a 1:1 ratio. Primers used in PCR amplification and DNA sequencing were *ITS*-4 (White et al. 1990) and a modified sequence of *ITS*-5 (White et al. 1990). The latter, designated *ITS*-1, has the sequence: GTC CAC TGA ACC TTA TCA TTT AG (L. Urbatsch, pers. comm.). The following PCR cycling protocol was used in amplification: a 95°C hot start for 12 min.; 40 cycles of: 95°C for 20 sec., 54°C for 30 sec., and 73°C for 1 min.; a 4 min. final extension at

73°C; and ending with a hold at 4°C. To confirm base positions, the *ITS*-1 & 2 and intervening 5.8S regions of *Thelesperma* were sequenced in both directions. The contigs, or unidirectional sequences, were assembled using Sequencher (Gene-Codes, Ann Arbor, MI) and visually checked. Base positions that gave equally strong, contrasting signals on both strands were coded as ambiguous according to the IUPAC-IUB ambiguity code set included in the program Sequencher. All characters were coded as unordered, and gap characters ("-") were treated as missing data rather than a fifth character state (Baldwin 1993).

Allozyme Data

An electrophoretic survey was performed to analyze allozyme variation at a variety of enzyme loci. A total of 765 plants were sampled from 25 natural populations (about 30 plants/population) representing all taxa in the *Thelesperma subnudum* complex, *T. longipes* A. Gray, and one outgroup population of *Bidens cernua* L. (Table 5). Fresh leaf material was collected in the field and kept on ice until returning to the laboratory (2-3 days maximum). Tissue was then ground using a mortar and pestle in the phosphate-PVP extraction buffer of Soltis et al. (1983). Extracts were absorbed onto wicks cut from Whatman 3MM filter paper and stored at -80°C until electrophoresis.

A total of 19 enzymes was surveyed electrophoretically for variability. Six enzymes, representing 11 putative loci, provided consistent, interpretable results. Two buffer systems were used to resolve these enzymes in 11.5% (w/v) starch gels. A tris-citrate/borate buffer system (System 6 of Soltis et al. 1983) provided good resolution for leucine aminopeptidase (LAP), phosphoglucoisomerase (PGI), phosphoglucomutase (PGM), and triosephosphate isomerase (TPI). A pH 7.5 modification of the morpholine-citrate buffer system of Odrzykoski and Gottlieb (1984) was used to resolve malate dehydrogenase (MDH) and shikimate dehydrogenase (SkDH). Staining schedules and protocols followed Soltis et al. (1983) and Murphy et al. (1996).

Genotypes were inferred directly from electromorphs observed on the stained gels, based on the assumption that enzyme substructure and compartmentalization parallel those observed in other flowering plants (Gottlieb 1981). When enzymes showed more than one allozyme locus, the most anodal (fastest migrating) locus was designated number 1, the next fastest number 2, etc. If more than one allele was present at a locus, the most anodal allele was designated *a*, the next fastest *b*, etc.

In a departure from common practice, the allozyme alleles detected at each locus were coded as present or absent for each taxon and included in a phylogenetic analysis. Although advocated by some (Mickevich & Johnson 1976; Mickevich & Mitter 1983; Buth 1984), this approach has been criticized by Swofford et al. (1996) because it violates the assumption of character independence. Similar treatment of allozyme data from *Mimulus* sect. *Erythranthe*

TABLE 5. Populations used in morphology, allozyme, and *nrDNA-ITS* studies of *Thelesperma*. Letters before collection numbers identify the following collectors: H = C.J. Hansen; S = C.J. Stubben; W = M. D. Windham; Wo = L. Allphin Woolstenhu me. All vouchers are deposited at the University of Utah herbarium (UT) unless otherwise indicated by upper case herbarium designators (based on Holmgren et al. 1990) following the collection numbers. x – no allozyme samples.

Taxa	(Code)	Geographic origin & voucher	Allozyme sample size	Sources for DNA (GenBank #)
T. caespitosum	(Thca1)	Utah: Duchesne Co.: *H and S 97-80*	30	#AY017361
	(Thca2)	Wyo: Sweetwater Co.: *H and S 97-91*	30	#AY017360
T. filifolium				
var. *filifolium*	(Thfi2)	Tex: Potter Co.: *Higgins 16391* (BRY)	x	#AY017365
var. *intermedium*	(Thfi1)	Wyo: Goshen Co.: *Nelson 25622* (RM)	x	#AY017364
T. longipes	(Thlo2)	NewM: Doña Ana Co.: *S 385*	29	#AY017355
	(Thlo1)	Tex: Culberson Co.: *Higgins 17688* (BRY)	x	#AY017354
T. marginatum	(Thma2)	Wyo: Fremont Co.: *H 97-134*	30	#AY017357
	(Thma1)	Wyo: Natrona Co.: *Hartman 38509* (RM)	x	#AY017356
T. megapotamicum	(Thme1)	NewM: Sandoval Co.: *Atwood et al. 24016* (BRY)	x	#AY017366
	(Thme2)	Utah: San Juan Co.: *Atwood 22534* (BRY)	x	#AY017367
T. pubescens		Wyo: Sweetwater Co.: *H and S 97-101*	29	
	(Thpu1)	Wyo: Uinta Co.: *H and S 97-111*	30	#AY017358
	(Thpu2)	Wyo: Uinta Co.: *H and S 97-117*	30	#AY017359
T. subnudum		Ariz: Coconino Co.: *Wo and H 97-141*	31	
		Ariz: Coconino Co.: *Wo and H 97-142*	33	
		Ariz: Coconino Co.: *Wo and H 97 143*	35	
		Ariz: Mohave Co.: *W 97-330*	30	
	(Thsu2)	Ariz: Mohave Co.: *H et al. 97-43*	39	#AY017351
		Nev: Clark Co.: *W 98-247*	27	
		Utah: Carbon Co.: *W and Heckel 2417*	30	
		Utah: Duchesne Co.: *H and Nielsen 97-71*	30	
		Utah: Emery Co.: *H and Wi 97-66*	30	
		Utah: Garf eld Co.: *H 97-79*	30	

continued

Taxa	(Code)	Geographic origin & voucher	Allozyme sample size	Sources for DNA (GenBank #)
		Utah: Grand Co.: *H and W 97-69*	30	
		Utah: Uintah Co.: *H and Nielsen 97-72*	30	
	(Thsu4)	Utah: Washington Co.: *H et al. 97-45*	36	#AY017352
		Utah: Wayne Co.: *H and W 97-57*	30	
		Utah: Wayne Co.: *H and W 97-68*	23	
var. *alpinum*	(Thwi1)	Utah: Wayne Co.: *H 97-73*	31	#AY017362
		Utah: Wayne Co.: *H 97-74*	30	
	(Thwi2)	Utah: Wayne Co.: *Anderson 922* (BRY)	x	#AY017363
Bidens cernua	(Bice)	Utah: Utah Co.: *H 97-144*	30	
		Ganders et al. 2000	x	#U67098
Bidens frondosa	(Bifr)	Utah: Utah Co.: *Welsh 608* (BRY)	x	
		Ganders et al. 2000	x	#U67094

(Windham unpubl.) produced a phylogenetic tree highly concordant with information from other sources, suggesting that these data may contain a strong phylogenetic signal in spite of their perceived limitations. The allozyme analysis undertaken here is presented as an experiment to further assess the value of enzyme data in phylogenetic reconstruction.

Phylogenetic Analyses

All phylogenetic analyses were performed using the computer program PAUP (*Phylogenetic Analysis Using Parsimony, version 3.1*; Swofford 1991) utilizing random stepwise addition. Only the shortest trees were retained in each search. All characters were considered unordered and given equal weights, with multistate characters treated as 'uncertain.' Characters and character states were tracked, organized, and manipulated using the computer program *MacClade 3.0* (Maddison & Maddison 1992). Nodal support in each topology was determined by100 bootstrap replicates (BS; Felsenstein 1985), as well as by calculating Bremer support values (BV; Bremer 1988, 1994b).

Separate and combined phylogenetic analyses were conducted on three data sets: morphology, *nrDNA-ITS* sequences, and allozymes. Examining all relevant data in a combined fashion can produce a more robust estimate of phylogeny than separate analyses by maximizing congruence among different sources of data in phylogenetic inference (Hillis 1987; Kluge 1989; de Queiroz et al. 1995; Nixon & Carpenter 1996). To estimate levels of congruence among data sets, incongruence length differences (ILDs) were calculated (Mason-Gamer &

Kellogg 1996; Johnson & Soltis 1998). This index measures the amount of extra homoplasy that results from the combination of two or more data sets, as described by Mickevich & Farris (1981) and Farris et al. (1994, 1995). The ARNIE program in the Random Cladistics software package (Siddall 1995) was used to determine the significance of ILDs. α-values less than 0.05 were considered sufficient evidence to reject the null hypothesis of data set homogeneity. Combined analyses included only those taxa common to all phylogenetic data sets.

RESULTS

Chromosome Data

All individuals sampled from populations of *T. pubescens* and *T. caespitosum* proved to be diploid with chromosome counts of $n = 12$ (Table 6; Figs. 2A–B). Individuals sampled from populations of *T. subnudum* var. *alpinum* consistently were tetraploid with $n = 24$ (Fig. 2C). Our analyses revealed that some Colorado Plateau populations of *T. subnudum* var. *subnudum* are diploid (n=12; Fig. 2D) whereas others are exclusively tetraploid (n=24; Fig. 2E). Although the geographic ranges of these cytotypes overlap and both appear to be common (Windham, Hansen, & Allphin unpubl. data), we have yet to identify a locality where they occur together. Both ploidy levels of *T. subnudum* var. *subnudum* are represented in the morphological, DNA, and allozyme analyses that follow.

A chromosome number was not obtained directly for *T. marginatum*, and no previously published counts were found in the *Index to Plant Chromosome Numbers*. However, an analysis of allozyme banding intensities in our collection from Fremont Co., Wyoming, provided strong evidence that the plants at this locality are diploid. This sample of *T. marginatum* showed only balanced heterozygote banding patterns, as is expected in diploid organisms (Danzmann & Bogart 1982b; Wendel & Weeden 1989) and observed in all chromosomally verified diploid populations of *Thelesperma*.

Morphological Data

Parsimony analysis of 16 morphological characters yielded two most-parsimonious trees, the strict consensus of which is shown in Figure 3. Relative to the outgroup species chosen, *Thelesperma* was strongly supported as a monophyletic group (BV=6, BS=100%). The first branch within the *Thelesperma* clade produces a trichotomy that separates *T. megapotamicum* and *T. filifolium* (both with unequally lobed disc florets and a well developed pappus) from the other species. The clade encompassing the remaining taxa is weakly supported (BV=1, BS=70%), branching to form a polytomy in which each taxon (with the exception noted below) occupies its own unresolved branch. The only deviation from this pattern is the grouping of *T. caespitosum*, *T. pubescens*, and *T. subnudum* var. *alpinum* in a single clade with strong support (BV=2, BS=88%). Within this clade, the last taxon is moderately supported as sister to *T. caespitosum* and *T. pubescens*.

TABLE 6. Chromosome counts on taxa belonging to the *Thelesperma subnudum* complex. Apparent first counts for a taxon are marked by a double asterisk following the relevant name. Letters before collection numbers identify the following collectors: H = C.J. Hansen; S = C.J. Stubben; W = M. D. Windham; Wo = L. Allphin Woolstenhulme.

Thelesperma caespitosum Dorn (= *T. pubescens* Dorn var. *caespitosum* (Dorn) C.J. Hansen)**			
n = 12	Utah	Duchesne Co.	1.2 mi up jeep road to Anthro Mtn. from Chokecherry Canyon (T7S, R4W, S18); *H and S 97-80* (UT)
n = 12	Wyo	Sweetwater Co.	ca. 3.3 mi past bridge on dirt road to Scott's Bottom SE of Green River (T18N, R106W, S31); *H and S 97-91* (UT)
Thelesperma pubescens Dorn (= *T. pubescens* Dorn var. *pubescens*)**			
n = 12	Wyo	Sweetwater Co.	ca. 0.3 mi S of switchback on dirt road leading up to Cedar Mtn. Summit (T13N, R112W, S10) *H and S 97-101* (UT)
n = 12	Wyo	Uinta Co.	ca. 0.6 mi past left fork to Sage Creek Mtn. (T13N, R113W, S3); *H and S 97-111* (UT)
n = 12	Wyo	Uinta Co.	NE summit of Hickey Mtn. at radio tower (T13N, R114W, S13); *H and S 97-117* (UT)
Thelesperma subnudum Gray			
n = 12	Ariz.	Mohave Co.	W of Wolf Hole Valley ca. 3.85 km ENE of Mustang Knoll (T39N, R12W, S31); *Ha, S, W and Wo 97-43* (UT)
n – 24	Utah	Washington Co.	W base of Smithsonian Butte (T42S, R11W, S21); *H, S, W and Wo 97-45* (UT)
Thelesperma subnudum Gray var. ***alpinum*** Welsh (= *T. windhamii* C.J. Hansen)**			
n – 24	Utah	Wayne Co.	WSW of Teasdale near the base of Boulder Mtn. (T29S, R4E, S20); *W 93-144* (UT)
n = 24	Utah	Wayne Co.	ca. 0.6 mi W of State St. in Teasdale on road to Bullberry Creek (T29S, R4E, S21); *H 97-73* (UT)
n – 24	Utah	Wayne Co.	ca. 0.8 mi S of SR 24 on dirt road to Government Creek (T29S, R4E, S18); *H 97-74* (UT)

ITS Sequence Data

Of 663 characters (aligned length), 61 were variable, and 6 were phylogenetically informative. The sequence of *T. caespitosum* was incomplete with approximately 87 bp missing compared to the other sequences. Possible non-specific amplification of the *ITS* region in *T. caespitosum* resulted in a double signal on the chromatogram. Multiple attempts to re-extract DNA and obtain a clearer signal failed. To determine if there was a loss of phylogenetically informative characters in the missing region of *T. caespitosum*, two different sequence length scenarios were analyzed. The first scenario involved aligning all sequence lengths equal to that of *T. caespitosum* (i.e., no gaps in *T. caespitosum* but with an 87 bp truncation in all other taxa). The second scenario was to align full sequence lengths in all taxa except *T. caespitosum* (i.e., 87 bp gap in *T. caespitosum* only). In both analyses, the same single most-parsimonious tree was obtained

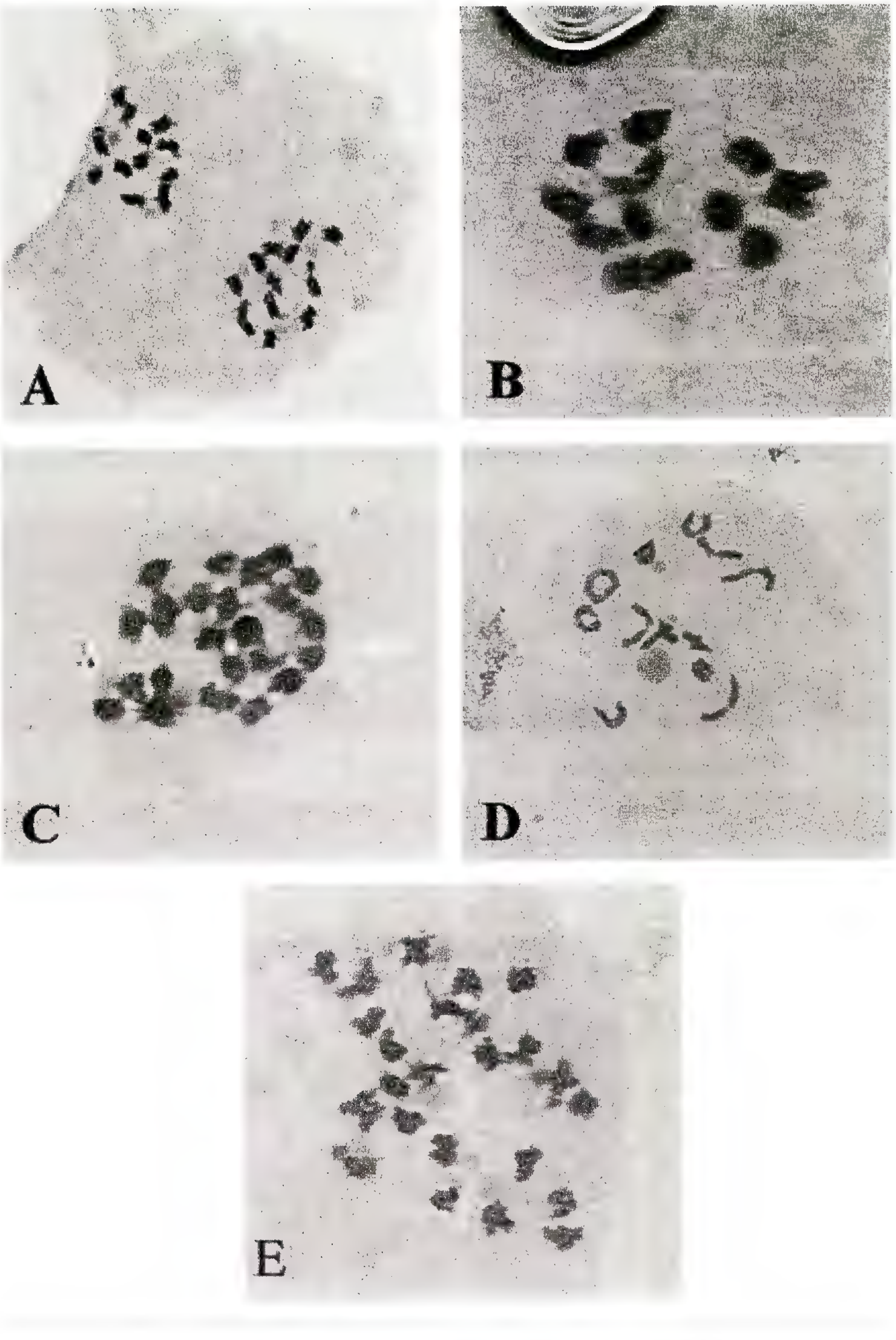


Fig. 2. Photomicrographs of chromosomes from four taxa in the *Thelesperma subnudum* complex. A) *T. pubescens*, n=12 (= var. *pubescens*, B) *T. caespitosum*, n=12 (= *T. pubescens* var. *caespitosum*), C) *T. subnudum* var. *alpinum*, n=24 (= *T. windhamii*), D) *T. subnudum*, n=12, E) *T. subnudum*, n=24.

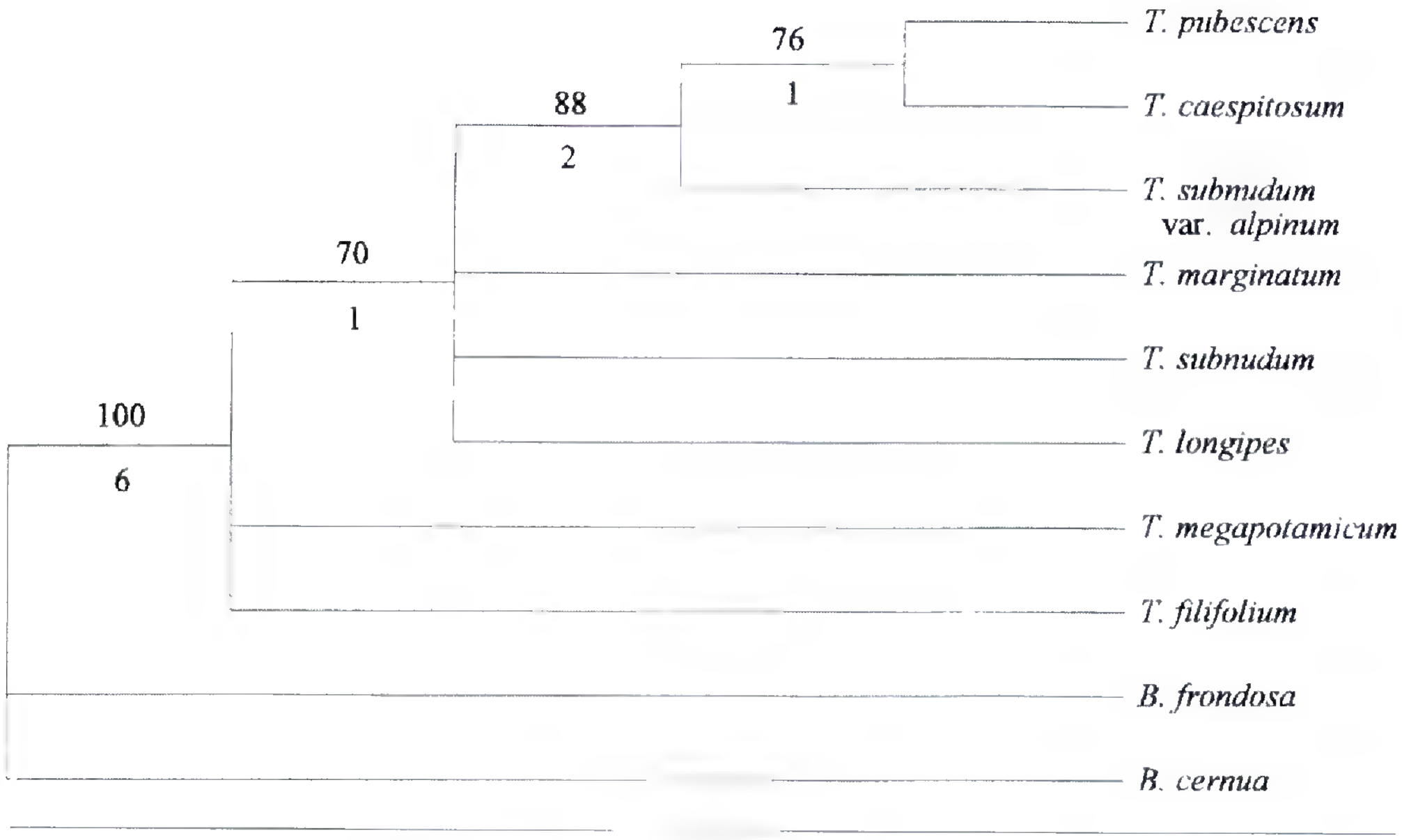


FIG.3. Strict consensus of 2 most-parsimonious trees based on morophological data. Bootstrap values are above the line, Bremer support values below. Length= 19, CI= 0.947, RI= 0.941.

(Fig. 4). Furthermore, bootstrap support only differed by 1–2 percent, being slightly higher in the second scenario. These results suggest that very few phylogenetically important characters are located in the 87 bp gap of *T. caespitosum* and subsequent combined analyses utilized the second scenario alignment.

The topology of the single most-parsimonious tree from the *ITS* sequence analysis was similar to that derived from morphology (Figs. 3, 4). The monophyly of *Thelesperma* is again supported by a 100% bootstrap value; Bremer support in the ITS data is significantly higher (BV=16). The only topological difference between the morphological and ITS trees involves the placement of *T. filifolium*. In the *ITS* analysis, this species forms a clade with all *Thelesperma* other than *T. megapotamicum* on a relatively well supported branch (BV=2; BS=86%). As in the morphological tree, all taxa on this branch form an unresolved polytomy with the exception of *T. pubescens*, *T. caespitosum*, and *T. subnudum* var. *alpinum*. Support for this clade is significantly higher in the *ITS* tree (BV=5; BS=99) and, once again, *T. subnudum* var. *alpinum* receives moderate support as the sister taxon of *T. caespitosum* and *T. pubescens*. A comparison of pair-wise distances based on the aligned *ITS* sequences shows very little divergence among these rare taxa (Table 7).

Allozyme Data

Missing allozyme data made up 5.3% of the total data matrix due to poor staining resolution of SKDH and PGI in populations of *T. marginatum* and *T. longipes*. The results of a phylogenetic analysis based on presence/absence data yielded

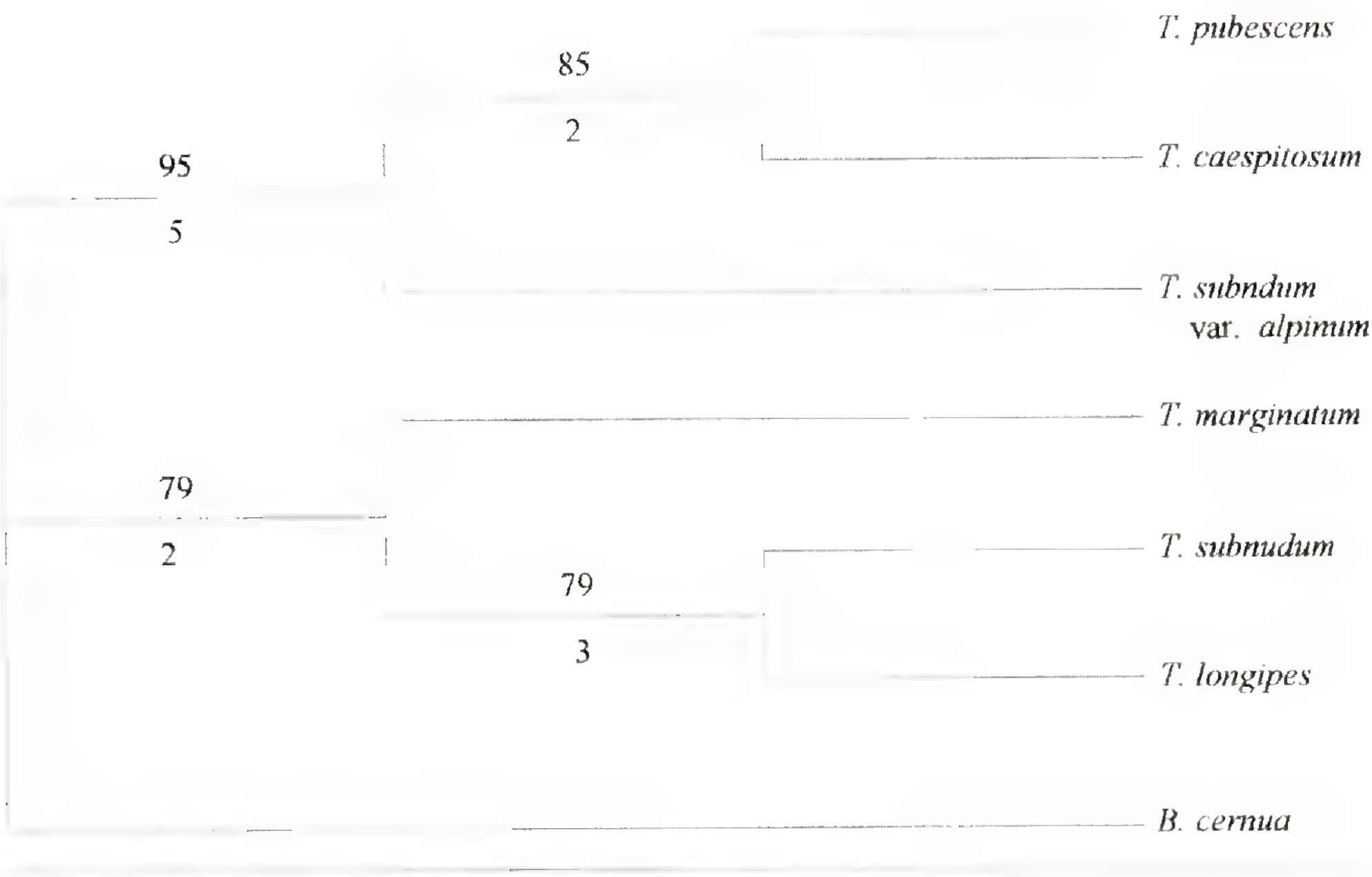


FIG.4. Single most-parsimonious tree from an exhaustive search based on ITS sequence data only. Bootstrap values are above the line, Bremer support values are below. Length= 70, CI= 0.986, RI= 0.968.

a single most-parsimonious tree (Fig. 5). Relative to the outgroup species *Bidens cernua*, the subset of *Thelesperma* taxa included in the allozyme analysis form two distinct clades. One consists of the three rare endemics, which show a strong association (BV= 5, BS=95%) comparable to that observed in the morphological and *ITS* trees (Figs. 3, 4). Once again, *T. subnudum* var. *alpinum* is sister to *T. caespitosum* and *T. pubescens*, and there is increased support for this topology (BV=2; BS=85%). The other *Thelesperma* clade recovered in the allozyme analysis (Fig. 5) consists of *T. marginatum*, *T. subnudum*, and *T. longipes*, which group together with moderate support (BV=2; BS= 79%). Nearly identical support (BV=3; BS=79%) exists for the placement of *T. marginatum* as the sister taxon to *T. subnudum* and *T. longipes*.

Combined Data Set Analysis

Statistical comparisons of trees resulting from the individual data sets revealed that they were highly congruent and amenable to being combined in a single analysis. This combined analysis of morphology, allozymes, and nrDNA-*ITS* sequences resulted in a single most-parsimonious tree, the topology of which was identical to that of the analysis based on allozymes alone (Fig. 6). Bootstrap and Bremer support values for the (*marginatum* (*subnudum/longipes*)) clade are not significantly different from those derived from the allozyme analysis. Support for the (*alpinum* (*pubescens/caespitosum*)) clade is increased by combining data sets. The association of these three taxa is supported by a 100% bootstrap estimate, and the Bremer support value increases to 12. Statistical

TABLE 7. Pair-wise divergence in *nrDNA-ITS* sequences for *Thelesperma* and *Bidens*. Percent divergence above diagonal; total number of nucleotide differences below diagonal (generated in PAUP 3.1). Codes for taxa provided in TABLE 6.

	Thsu2	Thsu4	Thlo1	Thlo2	Thma1	Thma2	Thpu1	Thpu2	Thca1	Thca2	Thwi1	Thwi2	Thfi1	Thfi2	Thme1	Thme2	Bice	Bifr
Thsu2		0	0.40	0.60	0.80	0.80	1.4	1.0	1.2	1.0	0.80	0.80	0.40	0.40	1.0	1.0	6.3	5.7
Thsu4	0		0.40	0.60	0.80	0.80	1.4	1.0	1.2	1.0	0.80	0.80	0.40	0.40	1.0	1.0	6.3	5.7
Thlo1	2	2		0.20	0.80	0.80	1.4	1.0	1.2	1.0	0.80	0.80	0.40	0.40	1.0	1.0	6.3	5.9
Thlo2	3	3	1		1.0	1.0	1.6	1.2	1.5	1.2	1.0	1.0	0.60	0.60	1.2	1.2	6.5	6.1
Thma1	4	4	4	5		0	1.8	1.4	1.5	1.4	1.2	1.2	0.80	0.80	1.4	1.4	6.7	6.1
Thma2	4	4	4	5	0		1.8	1.4	1.5	1.4	1.2	1.2	0.80	0.80	1.4	1.4	6.7	6.1
Thpu1	7	7	7	8	9	9		0.40	0.50	0.40	0.60	0.60	1.6	1.4	2.0	2.0	7.1	6.7
Thpu2	5	5	5	6	7	7	2		0	0	0.20	0.20	1.2	1.0	1.6	1.6	6.9	6.5
Thca1	5	5	5	6	6	6	2	0		0	0.20	0.20	1.2	1.0	2.0	2.0	6.9	6.4
Thca2	5	5	5	6	7	7	2	0	0		0.20	0.20	1.2	1.0	1.6	1.6	6.9	6.5
Thwi1	4	4	4	5	6	6	3	1	1	1		0	1.0	0.80	1.4	1.4	6.7	6.3
Thwi2	4	4	4	5	6	6	3	1	1	1	0		1.0	0.80	1.4	1.4	6.7	6.3
Thfi1	2	2	2	3	4	4	8	6	5	6	5	5		0.20	1.0	1.0	6.3	5.9
Thfi2	2	2	2	3	4	4	7	5	4	5	4	4	1		1.0	1.0	6.3	5.9
Thme1	5	5	5	6	7	7	10	8	8	8	7	7	5	5		0	6.1	5.7
Thme2	5	5	5	6	7	7	10	8	8	8	7	7	5	5	0		6.1	5.7
Bice	31	31	31	32	33	33	35	34	28	34	33	33	31	31	30	30		5.5
Bifr	28	28	29	30	30	30	33	32	26	32	31	31	29	29	28	28	27	

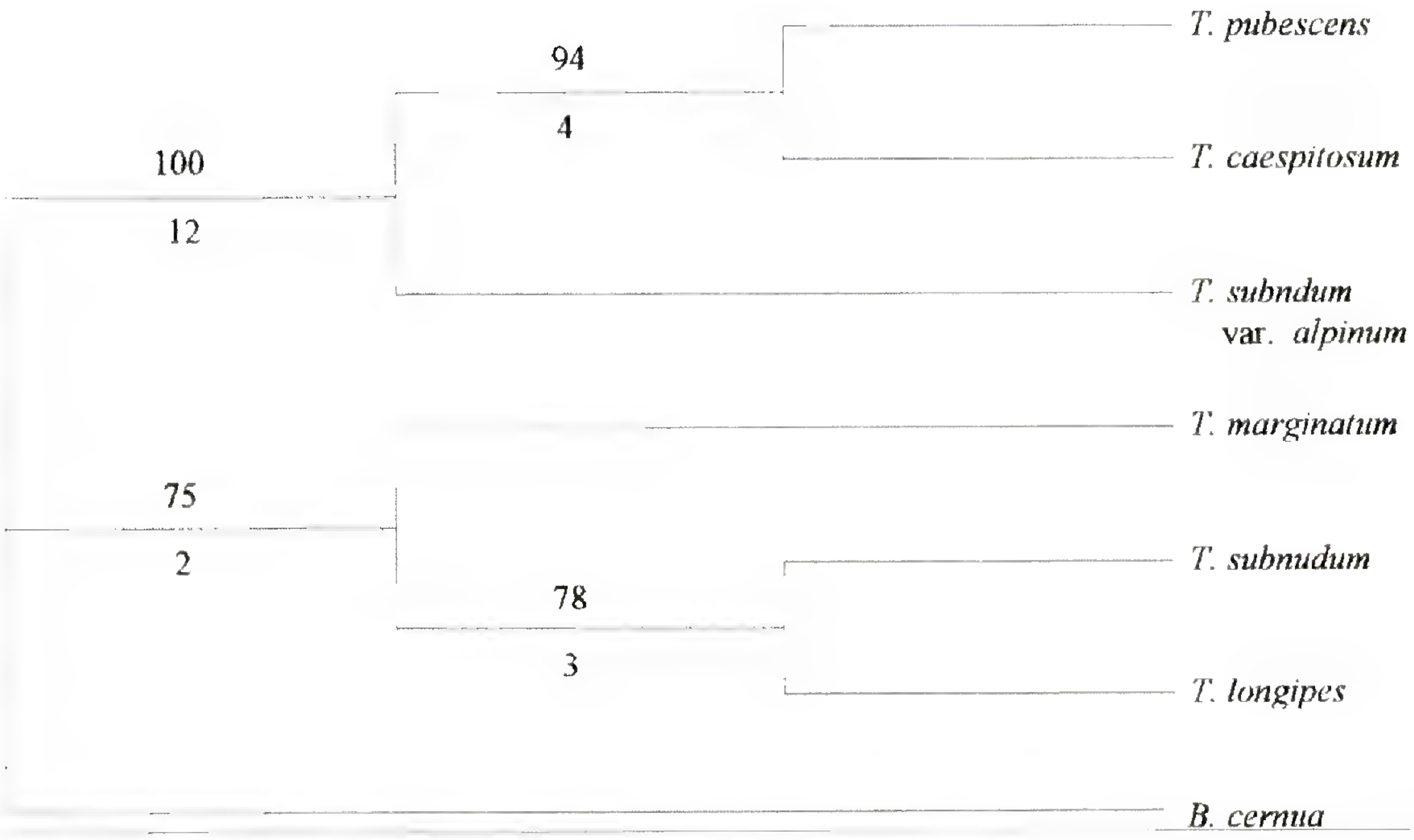


FIG. 5. Single most-parsimonious tree from an exhaustive search based on allozyme data only. Bootstrap values are above the line, Bremer support values are below. Length= 75, CI= 0.827, RI= 0.690.

support for the placement of *T. subnudum* var. *alpinum* as sister to the other two taxa increases as well (BV=4; BS=94%).

DISCUSSION

We gathered molecular and morphological data, which were analyzed separately and in combination to obtain the best estimate of the phylogeny of the *T. subnudum* complex. Tree topologies were highly concordant, and the single most-parsimonious tree from the combined analysis was more resolved and exhibited improved nodal support over any of the individual analyses.

The level of congruence among data sets in this study indicates that allozymes contain valuable phylogenetic information that can be recovered through parsimony analysis. This suggests that concerns regarding the independence of characters (Swofford et al. 1996) should not disqualify allozymes from playing at least a limited role in phylogenetic studies. Because this approach is relatively untested, however, we will refrain from placing undue emphasis on the allozyme tree in the following taxonomic discussion. This applies to the combined analysis as well, because the topology of that tree may be unduly influenced by the relative abundance of informative allozyme characters. The taxonomy outlined below addresses only those patterns independently observed in all data sets.

The relationships portrayed in our phylogenetic trees can be summarized as follows. *Thelesperma pubescens* and *T. caespitosum* are closest relatives, forming a clade in all analyses and showing very little divergence from one another

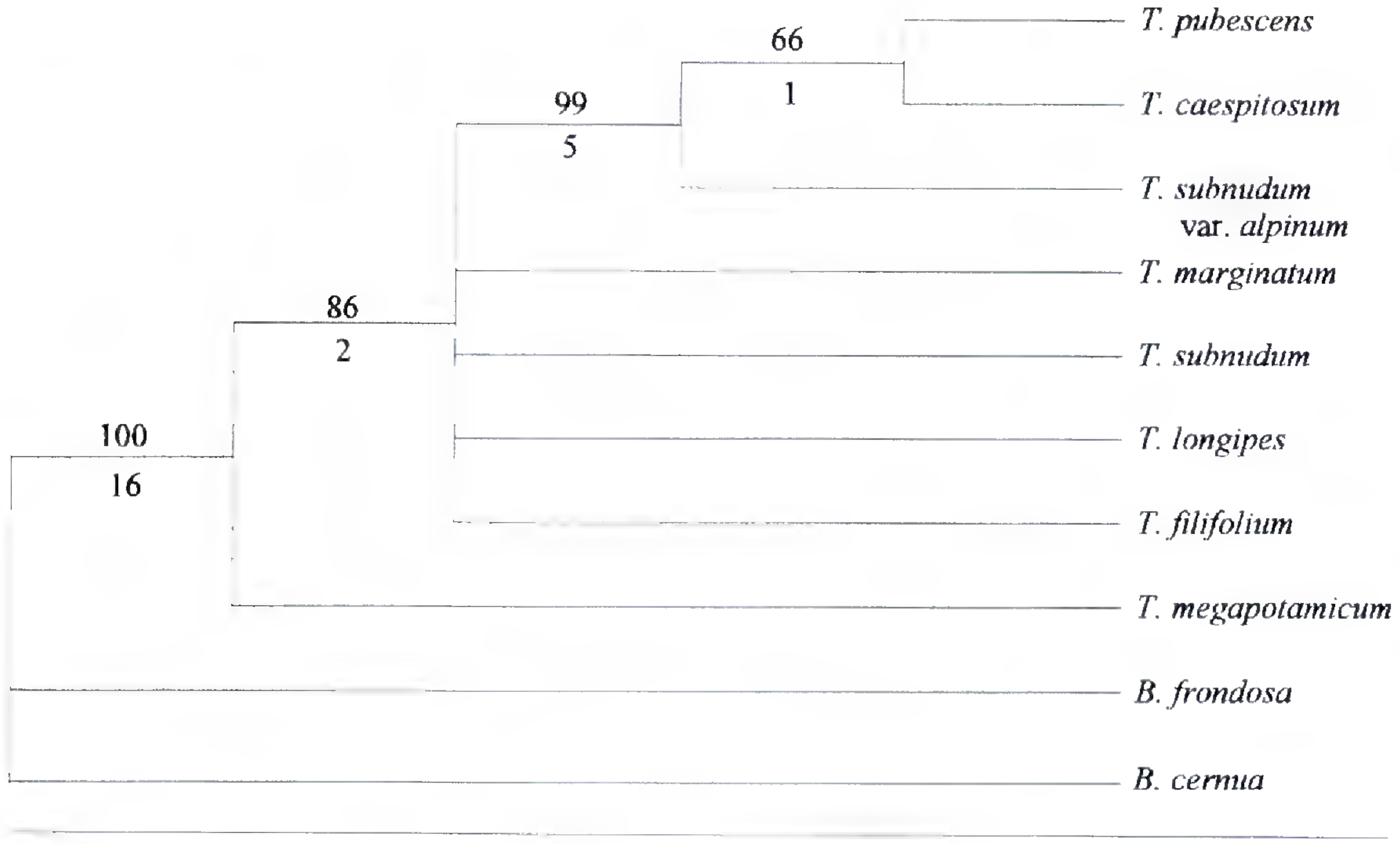


FIG. 6. Single most-parsimonious tree derived from combined analysis of allozyme, morphology, and *ITS*-DNA data sets. Bootstrap values are above the line, Bremer support values are below. Length= 137, CI= 0.905, RI= 0.772.

(Tables 4 & 7). Another relationship consistent across all analyses is the placement of *T. subnudum* var. *alpinum* as the sister taxon to the *T. pubescens/caespitosum* clade. Bootstrap support for this topology ranges from 88% in the morphological analysis to 100% in the combined analysis. Relationships among other taxa of the *Thelesperma subnudum* complex are poorly resolved, with the aforementioned clade forming a polytomy with *T. subnudum*, *T. marginatum*, and *T. longipes* in the morphology and *ITS* analyses (Fig. 3). In the allozyme and combined analyses (Fig. 4), those three taxa form a separate, moderately supported clade with *T. marginatum* basal to *T. subnudum* and *T. longipes*. These results are not wholly concordant with any of the proposed classifications of the *T. subnudum* complex summarized in Table 2, suggesting that nomenclatural changes are warranted.

The *Thelesperma pubescens/T. caespitosum* clade

Dorn (1990) recognized both taxa in this clade at the species level; Cronquist et al. (1994) combined them (and *T. subnudum* var. *alpinum*) under the name *T. pubescens*. Welsh et al. (1993) were mute on the matter of *T. pubescens* (which was not known to occur in Utah at the time the flora was published), but probably would consider it a variety of *T. subnudum*, the treatment accorded to *T. caespitosum*. The last classification is the least practicable in light of the data presented in this study. To treat *T. caespitosum* as a variety of *T. subnudum* and maintain monophyly, our data (Figs. 3, 4) indicate that other species would have to be subsumed within *T. subnudum* as well. These include *T. marginatum*, *T.*

longipes, and possibly even *T. filifolium*. We consider such a species concept, encompassing taxa not previously included in the *T. subnudum* complex, to be unacceptably broad.

Our data indicate that *Thelesperma pubescens* and *T. caespitosum* are sister taxa showing minimal genetic divergence. They differ by a single morphological character involving the distribution of pubescence on the leaves (Tables 3 & 4; Dorn 1990). Recent collections from near Anthro Mountain on the West Tavaputs Plateau in Duchesne Co., Utah (BRY- *Goodrich et al. 25159*) provide additional insight on their relationship. In that population, individual plants range from having strictly petiolar pubescence (*T. caespitosum* type) to complete leaf blade pubescence (*T. pubescens* type). Whether a result of incomplete primary divergence or secondary convergence resulting from hybridization or selection, there is complete intergradation. It appears that distribution of pubescence, in the absence of correlated characteristics, is probably a tenuous foundation for recognizing species in the *T. subnudum* complex.

Under the Biological Species Concept (Mayr 1942), *T. caespitosum* and *T. pubescens* are "groups of actually or potentially interbreeding populations" that probably should be recognized as conspecific. Invoking the Cohesion Species Concept (Templeton 1989), *T. pubescens* and *T. caespitosum* also qualify as conspecific based on phenotypic similarities (cohesion) due to gene flow by means of presumed interbreeding. Because these two taxa lack unique, diagnosable sets of morphological and molecular characteristics and don't appear to have separate evolutionary trajectories, they also would be considered a single species under the Phylogenetic Species Concept (Cracraft 1983; Davis & Nixon 1992).

With regard to the *caespitosum/pubescens* clade, our data are most congruent with the classification presented by Cronquist et al. (1994). In that treatment, *T. pubescens* is considered specifically distinct from *T. subnudum*, with *T. caespitosum* included within *T. pubescens*. We propose two modifications to this classification. First, we exclude *T. subnudum* var. *alpinum* from synonymy with *T. pubescens* for reasons that will be discussed below. Second, we propose to recognize *T. caespitosum* as a variety of *T. pubescens*. Excluding the intergradient population on Anthro Mountain, Utah, there is a definite correlation among pubescence, substrate, and geography (Table 1; Fig. 1). We feel that the incipient divergence in this clade is best recognized at the varietal level.

Origin and relationships of *Thelesperma subnudum* var. *alpinum*

This taxon appears to be exclusively tetraploid (Table 6), a point that is central to hypotheses regarding its evolutionary origin and to its classification. Tetraploids typically are derived from diploids through the incorporation of additional sets of chromosomes (see Harlan & DeWet 1975), and they are informally grouped according to the similarity of their constituent genomes (Crawford 1989). Polyploids containing genomes that are very similar chromosomally and genetically

(usually derived from within a single species) are considered autopolyploids. Because of genetic similarity to their progenitor diploids, autopolyploids are rarely given species status (e.g., Mosquin 1966). Polyploids that contain well-differentiated genomes (often obtained through hybridization between different species) are considered allopolyploids and usually treated as distinct species. The proper classification of *T. subnudum* var. *alpinum* thus hinges on whether it proves to be an autopolyploid or an allopolyploid.

Classifications of this taxon by Dorn (1990) and Welsh et al. (1993) imply that its closest relative is *Thelesperma subnudum*, and suggest that it may be an autopolyploid derived from within that species. Two lines of evidence refute that putative relationship. Although the taxon shows some morphological similarities to *T. subnudum* (Dorn 1990), the *ITS* sequence data clearly indicate a closer relationship to *T. pubescens* and *T. caespitosum*. In fact, all data sets developed during this study support the placement of *T. subnudum* var. *alpinum* as sister to these taxa, not *T. subnudum* var. *subnudum* (Figs. 3 & 4). Further evidence that var. *alpinum* is not an autopolyploid derivative of *T. subnudum* comes from the fact that known autopolyploids abound in this species and do not resemble var. *alpinum*. These undisputed autopolyploids in *T. subnudum* appeared identical to diploid *T. subnudum* in morphology and *ITS* sequences (Table 7). In our analyses, they were recognizable only through chromosome studies or the detection of unbalanced heterozygosity in allozyme markers shared exclusively with diploid *T. subnudum*.

Despite significant genetic similarity, it also seems unlikely that *Thelesperma subnudum* var. *alpinum* is an autopolyploid derivative of either *T. pubescens* or *T. caespitosum*. It varies toward *T. subnudum* in some morphological characters, most notably the somewhat creeping rootstock. The two taxa are similar enough to convince Dorn (1990) to maintain them as varieties of a single species. The presence, in most individuals, of a PGI-1 allele otherwise found only in *T. subnudum* and *T. marginatum* provides further evidence of genetic links to taxa outside the *T. pubescens/caespitosum* clade. Variety *alpinum* also shows several autapomorphic traits that distinguish it from *T. pubescens* and *T. caespitosum*, including pubescent flowering stems and unique allozyme variants.

We suspect that *T. subnudum* var. *alpinum* may be an allotetraploid resulting from hybridization between diploid *T. subnudum* and either *T. caespitosum* or *T. pubescens*. This would explain the pattern of shared characters and apparent morphological intermediacy that has led to such divergent classifications (Dorn 1990 vs. Cronquist et al. 1994). It also would explain allozyme banding patterns at the PGI-1 locus, where most individuals of var. *alpinum* are heterozygous for alleles derived from the *pubescens/caespitosum* and *subnudum/marginatum* clades respectively. At this one locus, var. *alpinum* approaches fixed heterozygosity, one of the genetic hallmarks of allopolyploidy. The absence of fixed heterozygosity at other allozyme loci may be due to homoeologous chro-

mosome pairing or extensive gene silencing (Windham 1988). Over time, allopolyploids lose expression of duplicated parental genes through various genetic processes, especially null mutations (Roose & Gottlieb 1976; Werth & Windham 1991). Given enough time, the polyploid taxon becomes genetically "diploidized" (Grant 1981).

A parallel process may explain the lack of diagnostic *T. subnudum ITS* sequences in var. *alpinum*. Recently formed allopolyploids would be expected to show the *ITS* sequences of both diploid parents (Soltis et al. 1995; Cook & Soltis 1999; 2000; Gernandt & Liston 1999). With time, however, *ITS* loci often experience concerted evolution, which randomly eliminates one of the parental sequences (Sang et al. 1995; Wendel et al. 1995; Polanco et al. 1999). Under this scenario, var. *alpinum* still could be an allopolyploid hybrid in which the original *T. subnudum* sequence has been lost to concerted evolution.

Each of the possible evolutionary origins (two autopolyploid and one allopolyploid) of *Thelesperma subnudum* var. *alpinum* discussed above would support a different classification for this taxon. The hypothesis that var. *alpinum* is an autopolyploid derived from *T. subnudum*, the only scenario congruent with the classifications of Dorn (1990) and Welsh et al. (1993), can be rejected. To uphold *alpinum* as a variety under *T. subnudum* and still maintain monophyly, we would have to expand the species definition of *T. subnudum* to include the entire complex plus *T. longipes* and, possibly, *T. filifolium* (Figs. 3 & 4). In our opinion, lumping half of the species in the genus *Thelesperma* into one species is not a desirable solution.

Our data are not sufficiently robust to distinguish between an autopolyploid origin of var. *alpinum* from within the *T. pubescens/caespitosum* clade or an allopolyploid origin through hybridization between members of that clade and *T. subnudum*. Nevertheless, we can propose a classification that would be phylogenetically congruent regardless of which scenario proves more plausible. To include var. *alpinum* within *T. pubescens* (as done by Cronquist et al. 1994) would be cladistically indefensible if *alpinum* subsequently is shown to be an allopolyploid. However, if we anticipate that the latter hypothesis is more plausible and recognize var. *alpinum* as a distinct species, such a treatment remains valid in the event that *alpinum* maintains its current position as the basal branch of the *T. pubescens/caespitosum* clade. Variety *alpinum* is morphologically distinct from the other members of this clade and, because of its polyploid chromosome number, is probably genetically isolated from the strictly diploid taxa. Thus, it can be recognized as a species under the Biological Species Concept (Mayr 1942) as well as the Phylogenetic Species Concept (Cracraft 1983; Davis & Nixon 1992; Davis 1996).

Other taxa in the *Thelesperma subnudum* complex

The two remaining taxa typically assigned to this complex are *T. subnudum*

and *T. marginatum*. Dorn (1990) treated them as distinct species; Cronquist et al. (1994) considered the latter a variety of *T. subnudum*. These taxa are part of an unresolved polytomy in the morphological and *ITS* data sets (Fig. 3), but form a moderately supported clade with *T. longipes* in the allozyme and combined trees (Fig. 4). The placement of *T. subnudum* as sister to *T. longipes* instead of *T. marginatum* in the latter trees suggests a relationship at odds with previous classifications, which exclude *T. longipes* from the *T. subnudum* complex. This result should be confirmed by additional studies before taxonomic revisions are proposed. Even if the allozyme data are discounted, there still is no support for expanding *T. subnudum* to include *T. marginatum* as proposed by Cronquist et al. (1994). Recognition of *T. marginatum* as a variety of *T. subnudum* would require its placement as sister to *T. subnudum* in a phylogenetic analysis. That these two taxa do not form a clade in any of our analyses suggests that they should continue to be treated as separate species. Each has a unique, diagnosable set of morphological and molecular characteristics indicative of a distinct evolutionary trajectory, thus satisfying the definition of a phylogenetic species (Davis & Nixon 1992).

In order to implement the classification outlined above, two nomenclatural innovations are necessary:

Thelesperma pubescens Dorn var. **caespitosum** (Dorn) C.J. Hansen, stat. nov. BASIONYM: *Thelesperma caespitosum* Dorn, Madroño 37: 293. 1990. TYPE: U.S.A. WYOMING. Sweetwater Co.: T18N, R106W, SE1/4 of SE1/4 of Sect. 31 and SW1/4 of SW1/4 of Sect. 32, 5 km SE of Green River, barren white shale ridge, 1890 m, 22 Jun 1988, *Dorn 4948* (HOLOTYPE: RM!).

Thelesperma windhamii C.J. Hansen, nom. et stat. nov. BASIONYM: *Thelesperma subnudum* A. Gray var. *alpinum* Welsh, Great Basin Naturalist 43: 369. 1983. TYPE: U.S.A. UTAH. Wayne Co.: T28S, R4E, S13 (NE1/4), 3 mi due N of Bicknell, bristlecone pine forest on multicolored clay hills, 2745 m, 20 Jul 1980, *Atwood and Thompson 7646a* (HOLOTYPE: BRY!).

This new name for *T. subnudum* var. *alpinum* honors the junior author, M.D. Windham, who proposed and co-directed the study. We chose not to raise the epithet *alpinum* to species rank because the taxon never occupies truly alpine habitats and most populations occur at moderate elevations (ca. 2200 m) in semi-desert regions.

KEY TO THE TAXA IN THE *THELESPERMA SUBNUDUM* COMPLEX (ASTERACEAE)

1. Leaves and stems glabrous or essentially so; leaves mostly 3–9 cm long; stems mainly 9–35(–50) cm tall, scattered along a somewhat creeping rhizomatous rootstock; rays present or absent; plants widely distributed.
   2. Ray florets present (rarely absent), scarious margins of inner involucral bracts mostly 1–1.5 mm or more wide; Nevada, Utah, Arizona, New Mexico, and Colorado _____ **T. subnudum**
   2. Ray florets absent, scarious margins of inner involucral bracts mostly 0.5–1 mm wide; Wyoming, Montana, Alberta, Saskatchewan _____ **T. marginatum**

1. Leaves or lower stems pubescent; leaves 1.5–4 cm long; stems mainly 3–19 cm tall, clustered on a thick, branching caudex with old, persistent leaf bases; ray florets absent; plant distribution restricted.
   3. Pappus a toothed crown; lower portion of flowering stems pubescent; plants from Wayne Co., Utah _____ **T. windhamii**
   3. Pappus absent; lower portion of flowering stems glabrous; plants from NE Utah and SW Wyoming.
      4. Leaves pubescent throughout; plants appearing gray-green _____ **T. pubescens** var. **pubescens**
      4. Leaves pubescent only on petioles or (rarely) on the proximal portion of the blade; plants appearing green _____ **T. pubescens** var. **caespitosum**

It is hoped that this revision of the *Thelesperma subnudum* complex will resolve some of the taxonomic confusion in the group. Although the treatment of *T. pubescens* and *T. caespitosum* as conspecific makes the aggregate taxon less rare, long-term monitoring and land management still will be necessary. All three rare taxa are restricted to specific substrates, and populations of *T. pubescens* near Green River and Hickey Mountain in Wyoming are endangered due to off-road vehicle use and oil and gas development. Populations of *T. windhamii* located west of Teasdale, Utah, are similarly threatened by off-road vehicle use.

To improve phylogenetic resolution, future studies should sequence more rapidly evolving regions of the *Thelesperma* genome, such as the external transcribed spacer regions of ribosomal DNA (Baldwin & Markos 1998). Artificial hybridization studies also might prove useful for revealing reproductive barriers and species boundaries. Ultimately, research should be expanded to include all taxa of *Thelesperma*. Deciphering relationships within *Thelesperma* will aid in identifying possible sister genera and thereby contribute to our knowledge of higher level relationships in the Coreopsidinae and Heliantheae.

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LIATRIS GHOLSONII (ASTERACEAE: EUPATORIEAE), A NEW BLAZING STAR FROM THE APALACHICOLA RIVER BLUFFS AND RAVINES IN FLORIDA

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ABSTRACT

A new species of *Liatris* (Asteraceae: Eupatorieae,) is described from Liberty County, Florida. Presumably its closest relative is *L. gracilis*, from which it differs in morphology, chemistry, and ecology. The species is diploid ($n = 10$).

KEY WORDS: Asteraceae, *Liatris*, blazing star, endemics

RESUMEN

Se describe una nueva especie de *Liatris* (Asteraceae: Eupatorieae,) del condado de Liberty, Florida. Probablemente su pariente más cercano es *L. gracilis*, de quien difiere en morfología, química, y ecología. La especie es diploide ($n = 10$).

The upper Apalachicola River region in the Florida panhandle has long been known for its diverse and unique flora. Asa Gray (1875) visited the area to observe *Torreya taxifolia* Arn. E.E. Callaway (1966), theologian, amateur archeologist, and one-time gubenatorial candidate in Florida, cited the unusual flora in support of his claim that the original Garden of Eden was located there. Further, he suggested the Torreya tree provided the Biblical "gopherwood" used in constructing Noah's ark. Although his ideas did not gain wide acceptance, many endemic taxa are nonetheless known from the area (Clewell 1977; Myers & Ewel 1990). It is the center of one of five "hot spots" for biotic rarity and richness in the continental United States (Stein et al. 2000). Now, a new species of *Liatris* can be added to the list of rare endemics found there.

For many years, local botanists, such as R.K. Godfrey and A.K. Gholson (pers. com.), have been aware of some unusual populations of blazing star in ravines and along the bluffs of the Apalachicola River in the Florida panhandle. The plants would most probably "key out" to *Liatris gracilis* Pursh, but they do not fit well.

Herz et al. (1984a) studied the chemistry of *Liatris gracilis*. Later, his team (Herz et al. 1984b) studied the "bluffs blazing star" and found that, in contrast to authentic *L. gracilis*, which contained an unusual group of germacrenolides, it possessed a distinctive group of heliangolides.

The Apalachicola bluffs plants are distinctive morphologically and chemi-

cally but have not been given nomenclatural recognition. The most recent summary of the genus (King & Robinson 1987) makes no mention of this taxon; neither does Wunderlin (1998) in his guide to the flora of Florida. It is here named *Liatris gholsonii* to honor Angus K. Gholson of Chattahoochee, Florida, an indefatigable field botanist and astute student of the local flora. Together, he and Godfrey collected an extensive population series of this new species.

METHODS AND MATERIALS

Vegetative and floral features of the new species and of *Liatris gracilis* were measured from the extensive population samples vouchered at FSU. Flowering heads were softened in a weak solution of NaOH in 50% ethanol to return tissues to their hydrated size and to facilitate dissection. Meiotic chromosome counts were determined from fresh flower buds preserved in Carnoy's solution (6:3:1 parts alcohol: chloroform: acetic acid). Gholson's personal herbarium is here termed "AKG"; it will eventually become part of FLAS.

SPECIES DESCRIPTION

Liatris gholsonii L.C. Anderson, sp. nov. (**Fig. 1**). TYPE: UNITED STATES. FLORIDA. Liberty Co.: shaded upper slopes of No Name Ravine on the Nature Conservancy's Apalachicola Bluffs and Ravines Preserve, T1N, R7W, SW1/4 Sec 7, 13 Sep 2001, *L.C. Anderson 19932* (HOLOTYPE: BRIT; ISOTYPES: FSU, MO, NY).

Herbae perennes plus minusve pubescentes et glanduloso-punctatae, caulibus 4.5–18.5 dm longis, eramosis infra inflorescentiam. Folia caulina inferiora petiolata 8–25 cm longa, laminis oblongo-lanceolatis 8–27 mm latis; folia superiora sessilia elliptica sursum sensim deminuentia. Inflorescentiae elongatae determinatae racemosae, pedicellis patentibus vel reflexis 2–26 mm longis. Bracteae florales infimae sessiles, anguste ellipticae, 2–5.9 mm longae, 1.8–9 mm latae. Capitula turbinata 6–10 mm longa, phyllariis 8–15 plerumque acutis ad acuminatis. Flosculi disci 3–6, corollis infundibuliformibus 6.7–10 mm longis roseis ad purpureis. Achaenia 4.5–4.8 mm longa 10-costata pubescentia, pappo barbellato 5–6 mm longo.

Perennial herbs, with spherical corm-like rootstocks 2–2.5 cm wide; radical leaves (usually absent at anthesis) long-petiolate, 22–25 cm long, blades entire, narrowly elliptic-oblong, 20–26 mm wide, glabrate, finely glandular-punctate on both surfaces. Stems (4.5–)5.5–12(–18.5) dm long, terete, striate, unbranched below the inflorescence, pubescent with hairs appressed or spreading. Cauline leaves alternate, entire, numerous, much longer than internodes, punctate; lower leaves (8–)13–22(–25) cm long, the petioles (2.5–)4–7(–10) mm long, ciliate, blades elliptic to oblong-lanceolate, tapering at base and tip, (8–)11–22(–27) mm wide, midveins raised and sparsely villosulous; leaves gradually reduced in size and becoming sessile toward the inflorescence, grading to the leafy floral bracts with little change in size or shape. Inflorescence elongate, determinate, racemose (rarely paniculate in damaged plants or frequently so in garden plants), pedicels spreading or reflexed at anthesis, pubescent, (2–)5–12(–26) mm long on heads toward base of inflorescence. Lowest floral bracts sessile, narrowly



FIG. 1. Plant of *Liatris gholsonii* (*Godfrey 76707.1*, a relatively small plant with few leaves to facilitate scanning) and enlargement of one head from *Anderson 19932*.

elliptic to lanceolate, (2–)2.5–4.5(–5.9) cm long, (1.8–)2–6(–10) mm wide. Heads turbinate-cylindric, (6–)6.5–8.5(–10) mm long, phyllaries (8–)9–12(–15), green to dark purple, ovate to oblong, acute to acuminate (rarely obtuse), glandular-punctate, ± ciliate, margins hyaline, white or roseate. Disk flowers 3–5(–6); corollas (6.7–)7–8.5(–10) mm long, narrowly funnelform, sparsely glandular punctate, throat pubescent internally, the tube ochroleucous or pinkish, the lobes pink to purple, slightly spreading to reflexed, (2.1–)2.5–3.6(–4.6) mm long; bifid styles pink, (11–)12–13(–14) mm long, anthers (2.5–)3.5–4(–4.4) mm long, with retuse appendages 0.2 mm long; mature achenes 3.5–5 mm long, 10-ribbed, gray except for raised, dull green ribs, narrowly turbinate, densely hispidulous, the

hairs 0.4–0.5 mm long, pappus strongly barbellate, 5–6 mm long, white, tinged with purple to give a dull rosy appearance. $n = 10$.

Phenology.—Primarily flowering from September to mid-October; a very few precocious plants blooming in early July and a few blooming in early November.

Habitat.—The species occurs in loamy sand or gravelly sand mostly in deep shade of deciduous woodlands on upper slopes of bayhead ravines or along the less shady ecotone between the woodland at tops of ravines adjoining more open scrub oak woodland. It also occurs in xeric to sub-mesic woodland and more or less open sites on bluffs facing the Apalachicola River or on sandy ridge tops between ravines.

Associated woody species include: *Asimina parviflora* (Michx.) Dunal, *Callicarpa americana* L., *Carya pallida* (Ashe) Engelm. & Graebn., *C. tomentosa* (Poir. in Lam.) Nutt., *Cornus florida* L. , *Diospyros virginiana* L., *Forestiera godfreyi* L.C. Anderson, *Fraxinus americana* L., *Ilex opaca* Ait., *Juniperus virginiana* L. , *Magnolia grandiflora* L., *Osmanthus americanus* (L.) Benth. & Hook. ex A. Gray, *Ostrya virginiana* (Mill.) K. Koch, *Persea borbonia* (L.) Spreng., Pinus *glabra* Walt., *Prunus alabamensis* Mohr, *Quercus alba* L., *Q. geminata* Small, *Q. hemisphaerica* Bartr., *Q. nigra* L., *Rhus copallina* L., *Sebastiania fruticosa* (Bartr.) Fern., *Sideroxylon lanuginosum* Michx., *Vaccinium arboreum* Marsh., and *Viburnum dentatum* L. A few herbaceous species are associates in the shaded sites, such as *Chasmanthium sessiliflorum* (Poir.) Yates, *Michella repens* L., *Smilax pumila* Walt., *Solidago arguta* Aiton, and *Spigelia marilandica* L.

Additional specimens examined (collections listed generally from north to south in occurrences): **FLORIDA. Liberty Co.:** Torreya State Park: 1 Oct 1972, *R.K. Godfrey 72216* (FSU), pine-hardwood forest, 8 Oct 1972, *R.K. Godfrey 72317* (FLAS, FSU); grassy trail in half shade, 9 Oct 1978, *R.K. Godfrey 76707* (FSU–population sample of 16 sheets); Weeping Ridge, 21 Sep 1983, *R.K. Godfrey 80984* (FSU); gravelly sandy soil, 12 Oct 1983, *R.K. Godfrey 81020* (FSU); just S of park entrance, 17 Oct 1988, *R.K. Godfrey 82931* (FSU); between picnic area and stone bridge, 24 Sep 1983, *A.K. Gholson 9348* (AKG); Rock Hill, 27 Sep 1969, *R.K. Godfrey 68853* (FSU); near Rock Bluff, 13 Oct 1956, *Redfearn & Godfrey 1026* (FSU, NCU); tributary off Spotts Branch, Upper Sweetwater Creek, 6 Jul 1989 (few in bloom this date), *R.K. Godfrey 83342* (FSU); N of Sweetwater at "old camp torreya," 21 Sep 1983, *R.K. Godfrey 80982* (FSU); ridge NW of Sweetwater, 5 Oct 2001, *L.C. Anderson 20018* (FSU, FTG, US, VDB), 16 Nov 2001, *L.C. Anderson 20075* (FSU), *L.C. Anderson 20077* (FSU); Apalachicola River bluff W of Sweetwater,16 Nov 2001, *L.C. Anderson 20081* (FSU); near rte 270 between rte 12 and Sweetwater, 26 Sep 1980, *R.K. Godfrey 78179* (FSU); No Name Ravine, 5 Oct 2001, *L.C. Anderson 20009* (FSU); cultivated in nature garden at Apalachicola Bluffs and Ravines Preserve headquarters building, 5 Oct 2001, *L.C. Anderson 20002* (BRIT, FSU, MO, NY, NCU, US), *20003* (BRIT, FSU, MO, NY); Beaver Dam Creek, 1.6 mi from rte 6 on rte 271, 15 Sep 1988, *R.K. Godfrey 82866* (FLAS, FSU); 1.65 mi from rte 6 on rte 270, 27 Mar 1991 (vegetative), *R.K. Godfrey 84073* (FSU); 1 mi from rte 12, 30 Sep 1983, *R K. Godfrey 80995* (AKG, FSU); arm of Little Sweetwater Creek, in shade, 30 Sep 1983, *R.K. Godfrey 80992* (FSU, 4 sheets), in sun, *80993* (FSU–4 sheets, UWFP); head of Little Sweetwater Creek near junction rte 270 and rte 12, 21 Sep 1983, *R.K. Godfrey 80975* (FSU); Alum Bluff, 10 Nov 1963, *D.B. Ward 3727* (FLAS), in shade, 3 Oct 1983, *R.K. Godfrey 81001* (FSU, 2 sheets), in sun, *81002* (FSU–3 sheets, UWFP); 4 Apr 1990 (vegetative), *R.K. Godfrey 83776* (FSU); in open, 2 Oct 1983, *A.K. Gholson 10643* (AKG, FSU), in shade, 2 Oct 1983, *A.K. Gholson 10644* (AKG, FSU); ridge by Kelley Branch, in shade, 2 Oct 1983, *R.K. Godfrey*

80998 (FSU), in sun, *R.K. Godfrey 80998* (FSU, 4 sheets), 2 Oct 1983, *A.K. Gholson 10642* (AKG), 24 Sep 1988, *L.C. Anderson 11834* (FSU).

DISCUSSION

Gaiser (1946) recognized 10 series of species in her monograph of *Liatris*. Series Graminifoliae (with obtuse, ciliolate phyllaries as in *L. gracilis*) and series Pauciflorae (which has generally larger heads with acuminate phyllaries that lack cilia) are relevant to this discussion. The phyllaries of *L. gholsonii* are ciliate (as in Graminifoliae) but usually acuminate (as in Pauciflorae). The distinctiveness of the two series was already diminished when Godfrey (1961) described *L. provincialis*; that Florida panhandle endemic has strongly acuminate but ciliolate phyllaries.

Gaiser (1950) studied the cytology in these series and found the species were all diploids (n = 10). The chromosomes were small with uniform karyotypes. For *Liatris gholsonii*, meiotic chromosome counts from buds of *Anderson 19932* were *n* = 10; the chromosomes were also very small, so chromosome numbers and karyotypes are not distinctive features taxonomically.

The new species appears most closely related to *Liatris gracilis*; both have small heads on relatively long, usually spreading pedicels. The two differ in their ecology, chemistry (Herz et al. 1984a, b), and morphology. Typical habitat for *L. gholsonii* is on more or less mesic, shaded ravine slopes and bluffs; only a few plants occur in full sun (in openings in the canopy from tree-fall or along the ecotone between the ravine and the adjacent sandhills), whereas *L. gracilis* typically occurs in sunnier, more xeric, open flatwoods and savannas. The two species are not sympatric, but *L. gracilis* does occur nearby in the same county.

Foliage is perhaps the most distinguishing feature separating the two species. Basal leaves on young plants are broadly elliptic in *Liatris gholsonii* (as in *Godfrey 84073*), whereas they are narrowly lanceolate in *L. gracilis* (see photograph in Gaiser 1950). Flowering plants of *L. gholsonii* tend to retain more of the basal and lower cauline leaves, which are also wider (mostly 11–22 mm wide) than those of *L. gracilis* (4–13 mm wide). The transition between cauline leaves and floral bracts is gradual in the new species, and the floral bracts are mostly 2–6 mm wide, whereas they are narrower (1.0–1.8 mm wide) in *L. gracilis*.

One might think the differences in foliage could be products of the species' differing habitats. In general, plants of the same or related species grown in full sun have smaller, narrower leaves than those found on plants grown in the shade. However, the larger leaves of *L. gholsonii* are not due to habitat. The few collections of *L. gholsonii* taken in full sun were more robust plants that had shorter internodes, average-sized cauline leaves for the species, but wider floral bracts than plants from shadier sites. Plants grown in full sun tended to have more phyllaries in their involucres (and thus be more like those of *L. gracilis*) than those grown in shade.

Personnel of the Apalachicola Bluffs and Ravines Preserve established a wildflower garden in full sun near their headquarters building. The garden soil was enriched with mushroom compost and was given supplemental water. Seeds of *Liatris gholsonii* from No Name Ravine were sown in the garden in 1997, and many plants became established. These plants are somewhat atypical in having mostly two or three stems per rootstock and large, paniculate inflorescences. These "full sun" plants still had the characteristic leaves and floral bracts of *L. gholsonii*.

Several features of floral morphology tend to separate to two species, but variation is sufficient within each species that no single feature provides absolute identification. For example, phyllaries in the new species tend to be acuminate, but some plants have phyllaries that are only acute (or rarely obtuse), and phyllaries in *Liatris gracilis* are usually very obtuse (rounded apically), but a few specimens have phyllaries that are acute or rounded but mucronate. Summation of some floral measurements from over 30 samples per species is in Table 1. Plants of *L. gholsonii* tend to have shorter involucres (shortest in the genus) with fewer phyllaries, but their corollas and achenes tend to be larger than those of *L. gracilis*.

Differences between the two species in floral morphology (Table 1) are present (though minimal is some cases). The salient distinguishing features between the two taxa are mostly vegetative; the following key couplet provides a useful summary:

Lower floral bracts over 2 mm wide; lower cauline leaves elliptic, mostly over 12 mm wide; phyllaries usually acuminate, rarely obtuse _____ **Liatris gholsonii**

Lower floral bracts under 2 mm wide; lower cauline leaves lanceolate, mostly under 12 mm wide; phyllaries usually obtuse, rarely acute _____ **Liatris gracilis**

Now the Florida panhandle has two endemic species of *Liatris*; *L. provincialis* is found in Franklin and Wakulla counties and is considered endangered in Florida (Coile 2000). The range of *L. gholsonii* is even more restricted; it ranges about 14 km from Torreya State Park to just south of Alum Bluffs and occurs on bluffs or in ravines only a short distance eastward from the Apalachicola River. The most distant population from the river is found in the headwaters of Sweetwater Creek about 9 km from the river. This species is clearly a candidate for listing as endangered.

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TABLE 1. Averages (and ranges) of selected floral features in *Liatris gholsonii* and *L. gracilis*.

	Liatris gholsonii	Liatris gracilis
Involucral length, mm	6.96(6.0–10.0)	7.62(5.5 10.0)
Phyllary number	10.69(8–15)	12.33(9–16)
Flower number	4.06(3–5)	4.30(3 7)
Corolla length, mm	7.84(6.8–9.8)	7.69(6.0–9.7)
Corolla lobe length, mm	3.09(2.1–4.6)	2.82(2.0–3.9)
Anther length, mm	3.80(2.6–4.5)	2.98(2.0–3.9)
Achene length, mm	4.07(3.5–5.0)	3.40(2.8 4.4)

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BOOK REVIEW

GEORGE E. BURROWS and RONALD J. TYRL. 2001. **Toxic Plants of North America.** (ISBN 0-8138-2266-1, hbk.). Iowa State Press, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax; www.iowastatepress.com). $174.95, 1350 pp, 8 color plates, numerous line drawings, 8 1/2" × 11".

What a magnificent book this is! It is a hefty (nearly 1400 pp. and 8 lbs.) treatment of the plants in North America that are known to be toxic to humans and domestic animals. The combined insights of the two authors, a veterinary toxicologist and plant systematist respectively, provide a breadth and depth of coverage that make this work a worthy successor to the earlier books of L.H. Pammell (1911) and J.M. Kingsbury (1962).

The work organized for easy use. There is a brief introductory chapter, which includes a delightful dedication to the late Dr. J.W. Dollahite of Texas A&M University, who made important contributions to veterinary toxicology in through the middle 20th century. Then comes the alphabetically arranged treatments for 75 families of plants that are known to be poisonous. The treatments are divided into genera, and the treatment for each genus includes a consideration of the species. Nomenclature conforms to current floristic usage in North America. There is a general description of the plant and a statement of range and habitat that are designed to permit ready identification. Each toxic plant or group of closely related plants is given a discussion of the disease problems, disease genesis, clinical signs, pathology, and treatment & control. The page margins are wide, and printed there are line drawings and generalized distribution maps for each plant. Short phrases in boldface noting the topics in the text are also given in the margins. Structural formulas are provided for the various toxins that are discussed in the text. A nice touch is the colored photographs of 64 toxic plants, presented on 8 colored plates in the center of the volume

After the families of known toxic concern, there is a less detailed chapter on 36 other families that are of doubtful or merely suspected toxicity. Then comes a short discussion on plant identification, a list of plants by their adverse effects, a list of plants of concern for dogs, cats, and other pets, an extensive glossary, and an index.

Each family treatment has its own list of references, and the lists are extensive and current. For example, the family Euphorbiaceae, which includes numerous toxic plants, has 194 entries in the list of references. These come from the veterinary, general toxicological, and botanical literature, and most of the references are from the past 25 years. Lengthy reference lists are given for other families as well, which make the book a rich bibliographic tool for researchers. A cursory pass-through showed all references to be from the English language literature.

A particularly attractive feature is the simple accessibility of the contents. A person needing information about a toxic plant (such information is often needed in a hurry) can locate the information easily and rapidly, and that is remarkable for such a large, encompassing book.

The book is an expensive reference work and doubtless some users will know of things that the authors might have included, but had the authors opted for perfection, the book would never have been completed. Instead of a piddly quibble here and there, we can all be grateful that the work was completed and made available to the great community of consumers of botanical and toxicological information.—*Theodore M. Barkley, Botanical Research Institute of Texas, barkley@brit.org*

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A NEW SPECIES OF *GONOLOBUS* (APOCYNACEAE: ASCLEPIADEAE, GONOLOBINAE) FROM SOUTHERN COSTA RICA

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ABSTRACT

A new species of *Gonolobus* is described, resulting from collections from southern Costa Rica.

RESUMEN

Se describe una especie nueva de *Gonolobus* como resultado de recientes colecciones del sur de Costa Rica.

Recent study of lianas and vines in southern Costa Rica resulted in a preliminary checklist of seventy species in thirty-two families from the Las Cruces Biological Station (Krings 1999). Ongoing work with collections resulting from this study revealed a new species of *Gonolobus* Michx. (Apocynaceae: Asclepiadeae, Gonolobinae).

Gonolobus tenuisepalus Krings, sp. nov. (**Fig. 1**). TYPE: COSTA RICA. PUNTARENAS: Coto Brus, San Vito de Java, Estación Biológica Las Cruces, 30 m downhill from Trail Marker Ft 59, 1200 m elev., 11 Mar 1997, *Krings 274* (HOLOTYPE: F; ISOTYPES: CR, NCSC, US).

Species nova *Gonolobus* distinguibili a *Gonolobus jaliscensis* B.L. Rob. & Greenm. petioli c. 4–4.3 cm longi; sepala lineare vel anguste lanceolata, supra glabrata, subtus dense pilosa, 5–7.2 mm; corollae purpureis, lobi deltatis, supra puberulis, subtus pilosis.

Twining vine; indument of short and long hairs, the short hairs straight, pointed or sometimes capitate, to 0.4 mm long, borne primarily along the stem, midvein, and secondary veins, long hairs straight to flexuously curved, (2–)2.8–3.5(–4.3) mm long, borne along stem, veins, and over leaf surfaces; stems densely yellowish-clear pilose or hirsute; latex white, abundant; petioles 4–4.3 cm long, densely yellowish pilose to hirsute; leaves opposite, 12–14 cm long, 6.8–8 cm wide, ovate, densely yellowish pilose to hirsute on both surfaces, the bases cordate to somewhat auriculate, frequently oblique, the apices acuminate; inflorescences axillary, umbelliform, densely 9–15-flowered, the peduncles 0.5–1 cm long; pedicels 7–9 mm long, densely yellowish pilose to hirsute, the hairs to 3 mm long; flowers mildly fetid; sepals 5, linear to narrowly lanceolate, 5–7.2 mm long, pilose or hirsute on the outer surface, glabrate on the inner surface; corolla campanulate

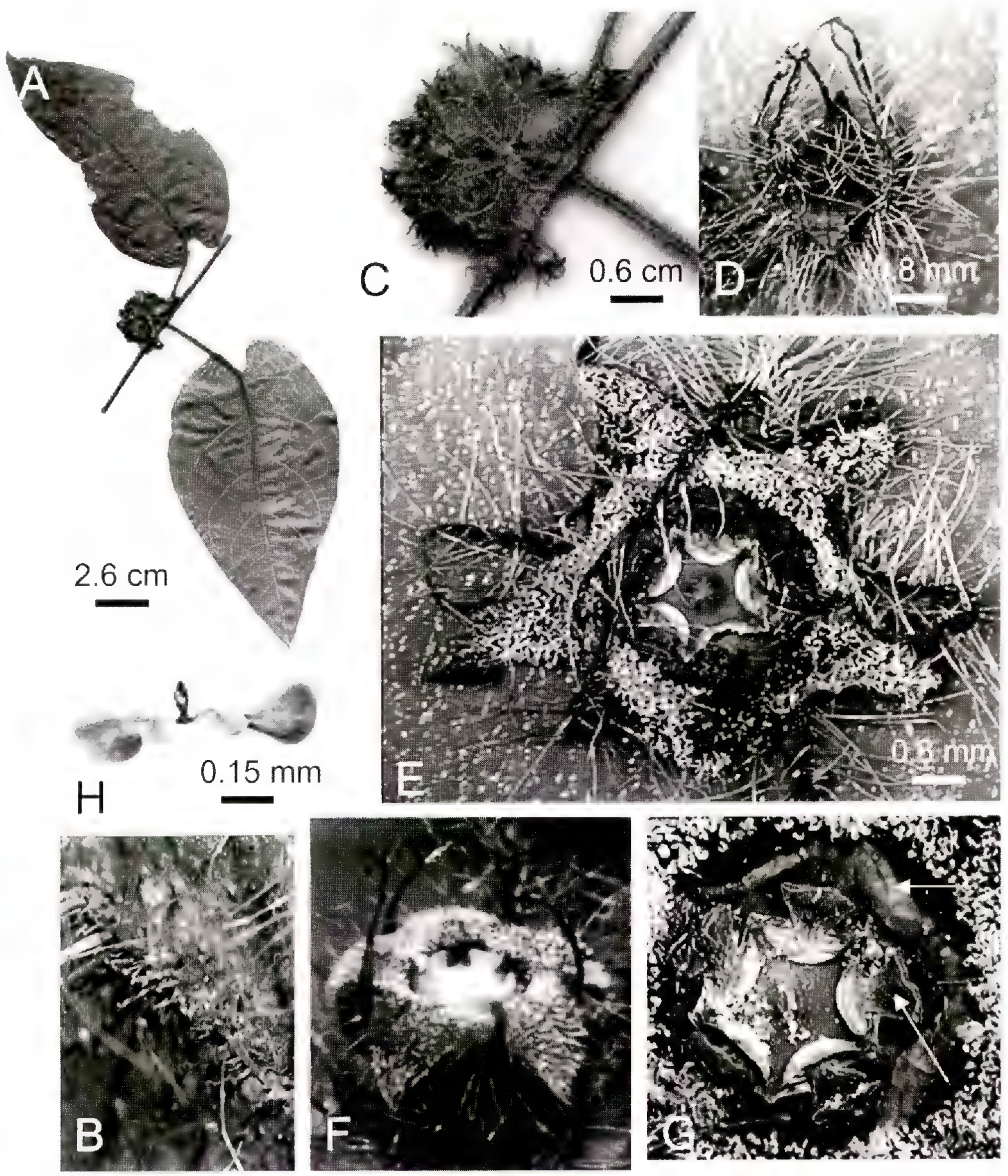


FIG. 1. *Gonolobus tenuisepalus* Krings: A. Leaves and inflorescence; B. Long and short stem trichomes; C. Inflorescence; D. flower in bud; E. Dried, flattened flower; F. Living flower, showing erect sepals and anther appendages; G. Detail of flattened flower (horizontal arrow indicates glabrous faucal annulus; diagonal arrow indicates anther appendages); H. Pollinarium. All based on *Krings 274* (HT: F; IT: CR, NCSC, US).

to suburceolate, 5-lobed, the tube 1–2.5 mm long, the lobes deltate, uniformly flat, dark purple to dark brownish-red, 3–4 mm long, conspicuously shorter than the sepals, long yellowish pilose to hirsute below, the hairs to 2.8 mm long, coarsely villosulous-strigillose above; faucal annulus 5-lobed, ca. 0.05-0.1 mm thick, glabrous; corona 1, 5 -lobed, fused at the base, adnate to and surrounding

the gynostegium, the lobes deltoid to rhomboid, essentially as high as the stylehead, 0.4–0.5 mm high; anthers with fleshy, obdeltate, dorsal appendages; pollinaria horizontal, ca. 0.5 mm long; follicles unknown.

Gonolobus comprises about 150 species limited to the New World tropics and subtropics (Stevens 2001). *Gonolobus tenuisepalus* appears to be closely related to *Gonolobus jaliscensis* B.L. Rob. & Greenm., sharing indument of short and long hairs, densely multi-flowered, umbelliform inflorescences, small corollas (ca. 8 mm in diam.), and similar coronas and anther appendages. *Gonolobus jaliscensis*, however, exhibits petioles shorter (to 2.2 cm long), sepals shorter (only to 2 mm long), corollas greenish to yellowish (purple in *G. tenuisepalus*), and anther appendages mushroom-shaped. With the addition of *G. tenuisepalus*, nine species of *Gonolobus* are known from Costa Rica (two yet undescribed, see Stevens 2001). An updated key follows:

1. Corollas barbellate within or with barbed lobes.
   2. Abaxial and adaxial leaf surfaces glabrous, except scattered appressed-pilose along the principal veins and in the axils; faucal annulus glabrous; anther appendages ⩾ 1.4 mm long _____ **Gonolobus barbatus** Kunth
   2. Abaxial and adaxial leaf surfaces puberulent; faucal annulus ciliate (although this sometimes hidden by the barbellate hairs of the corolla limb); anther appendages ca. 0.9 mm long _____ **Gonolobus edulis** Hemsl.
1. Corollas variously glabrous or pubescent, but not barbellate or barbed.
   3. Corolla purple, the lobes 4 mm long or less; faucal annulus 0.05-0.1 mm high, essentially a 5-lobed ridge; anther appendages obdeltate, ca. 0.5 mm long _____ **Gonolobus tenuisepalus** Krings
   3. Corolla greenish or yellowish (sometimes purple in *G.* sp. B and *G.* sp. D), the lobes ⩾ 6 mm long; faucal annulus various; anther appendages lacking (*G.* sp. B) OR ⩾ 0.3 mm long and variously shaped, the apices entire, bifid, or with a central mamillate tip.
      4. Outer petal surface with trichomes 0.8–1.5 mm long; anther appendages bifid _____ **Gonolobus heterophyllus** (Hemsl.) W.D. Stevens.
      4. Outer petal surface glabrous or the trichomes ⩽ 0.4 mm in length; anther appendages entire, mamillate tipped, or lacking, but not bifid.
         5. Corolla lobes ⩾ 15 mm long; anther appendages subquadrate, 1–2 mm long _____ **Gonolobus albomarginatus** (Pittier) Woodson
         5. Corolla lobes ⩽ 12 mm long; anther appendages various or lacking.
            6. Corolla purple, the lobes 7.2–9.5 mm long, the apices concave; faucal annulus an erect, 5-lobed tube, 0.7–1.2 mm long; anther appendages lacking _____ **Gonolobus** sp. B
            6. Corolla greenish or yellowish (sometimes purple in *G.* sp. D), the lobes of various lengths, planar; faucal annuli various, sometimes an indistinct ridge (e.g., *G. chiriquiensis*); anther appendages present.
               7. Leaf bases truncate to rounded; antner appendages rounded, with a short, central, mammillate tip _____ **Gonolobus chiriquensis** (Woodson) Woodson
               7. Leaf bases cordate; anther appendages various.
                  8. Corolla purple, brownish, or green, the tube 1.7–2.7 mm long, the

lobes 6.6–11.7 mm long, 3.2–4.7 mm wide; gynostegium stipitate, the stipe 0.3–0.6 mm long; corona cup-shaped _____ **Gonolobus** sp. D

8. Corolla green, the tube 3.7–5.7 mm long, the lobes 12.2–18.2 mm long, 7.8–12.5 mm wide; gynostegium essentially sessile; corona not cup-shaped _____ **Gonolobus denticulatus** (Vahl) W.D. Stevens

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A NEW SPECIES OF *MEDINILLA* (MELASTOMATACEAE) FROM ANAMALAI HILLS, SOUTH INDIA

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ABSTRACT

An undescribed species of the genus *Medinilla* Gaud., from the Anamalai Hills, South India, is described and illustrated.

RESUMEN

Una especie no descrita del género *Medinilla* Gaud., de Anamalai Hills, sur de India, se describe y se ilustra.

INTRODUCTION

Medinilla Gaud., an Afro-asiatic genus is estimated to have 430 species (Veldkamp pers. comm.). The genus has a bicentric distribution pattern due to the movement of landmasses during the late Cretaceous period from a Gondwanian origin (Nayar 1972). In Asia, the distribution ranges from Indian-Himalaya southwards to Sri Lanka, Myanmar, Thailand, Cambodia, Vietnam, Malay Peninsula eastward through the islands of the Malay Archipelago, New Guinea down to Northern Australia, and is adapted to warm humid paleotropical climate. More than 300 species are reported from the Indo-Malaysian region (Nayar 1966). Malayan regions and Madagascar are the principal centers of diversity and endemism- Philippines: 80 species, Madagascar: 70 species, Borneo: 48 species (Perrier 1951; Regalado 1990, 1995). Nayar (1972) has analyzed the distribution pattern of Asiatic Melastomataceae and recognized four centers. The Western Ghats is included in the Deccan-Ceylon center (Peninsular India and Sri Lanka) of species formation. Among the 9 Indo-Sri Lankan species, 5 are reported from Peninsular India and Sri Lanka and others are confined to the subtropical Himalayas and Assam hills. *Medinilla beddomei* Clarke and *M. malabarica* Bedd. are exclusive to Southern Western Ghats and the third species, *M. fuchsioides* Gard., formerly considered endemic to Sri Lanka, was recently reported from Southern Western Ghats (Shetty & Karthikeyan 1976).

During explorations in the windward region of Southern Western Ghats, interesting specimens of *Medinilla* were collected from three localities of Anamalai Hills. The specimens did not agree with the species known from India and Sri Lanka. Further study with literature on *Medinilla* (Bremer 1987; Perrier 1951; Regalado 1990, 1995) shows that the specimens have more affinity to Indo-Sri Lankan

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species and is allied to *Medinilla malabarica* Bedd. The specimens were further compared with the collections from Indo-Malaysia in the Kew Herbarium and no matches were found. It is described and illustrated here as a new species.

Medinilla anamalaiana Sasidharan & Sujanapal, sp. nov. (**Fig. 1**). TYPE: INDIA. KERALA: Palakkad District, Parambikulam Wildlife Sanctuary, Shekkal mudi 1200 m, 1 May 1999, *P Sujanapal* 19431 (HOLOTYPE: MH; ISOTYPES: CALI, KFRI, L).

Medinilla anamalaiana M. malabaricae affinis in habitu omnium foliorum innovatiorumque rufobrunneorum, sed surculis succulentis (sub)quadrangularibus, foliis membranaceis 3-costatis, apice obtuse acuminato, inflorescentiis axillaribus vel e axillis defoliatis in seriebus horizontalibus, floribus breve pedicellatis gerentibus distinguendum. In *M. malabarica* rami annotini teretes indurati folia crasse coriacea 5-costata, apice acuto vel obtuso, flores in cymis pedunculatis gerentes.

Epiphytic subshrubs; branches fleshy, acutely quadrangular or subquadrangular, sparingly branched, sometimes rooting from lower nodes, smooth, on drying forms a winged appearance; stem 20–35 cm long, young shoots reddish-brown. Leaves membranous, opposite pairs unequal, sometimes equal, larger one 7–11.5 × 3–5 cm, smaller 4–6 × 2.5–3.5 cm, elliptic-oblong, base subcordate or obtuse, apex obtusely acuminate, acumen sometimes twisted, margin entire, 3-nerved, lateral ribs near the margins, faint towards apex; petiole 2–4 mm, flattened, glabrous. Flowers 4-merous, 2–5 in axils or from leafless nodes in horizontal row, sometimes 2 or 3 on a short stalk (1–2 mm); pedicel with 2 minute bracteoles at base, jointed, 2 mm at anthesis, elongating to 4 mm in fruit; hypanthium obovate, subquadrangular, 3 mm across, thinly puberulous, shortly narrowed at mouth with 8 minute teeth; petals 5–7 × 4 mm, rose-pink, obliquely obovate, minutely apiculate; stamens 8, filaments 3 mm long; anthers 2 mm long; ovary 1.5 mm across, obovoid, 4-celled, connected to hypanthium with 8 membranous appendages; style to 7 mm long; stigma minutely capitate, papillate. Berries 4 mm across, globose, glabrous; crowned by a small hypanthial limb; seeds many, yellowish-brown, 1.5 × 1 mm, smooth, ovoid, concave on the side of raphe.

Medinilla anamalaiana is allied to *M. malabarica* Bedd. in the general appearance of the leaves and reddish-brown tender shoots. However, it can be distinguished from the latter by the succulent quadrangular or subquadrangular branches, 3-nerved membranous leaves with obtusely acuminate apex and short pedicelled flowers in axils or from leafless nodes in horizontal rows. *Medinilla malabarica* Bedd. has terete woody branches, 5-nerved thickly coriaceous leaves with acute or obtuse apex and flowers in pedunculate cymes.

Note.—The floral structure of *Medinilla* appears to be uniformly similar in most of the species and is not much diagnostic value. Because of the high rate of endemism in *Medinilla* most of the workers followed geographic distribution in addition to morphological or vegetative characters in their regional revisions or floristic works. Our taxonomic concept for describing *M. anamalaiana* also follows the same approach in addition to morphological characters.

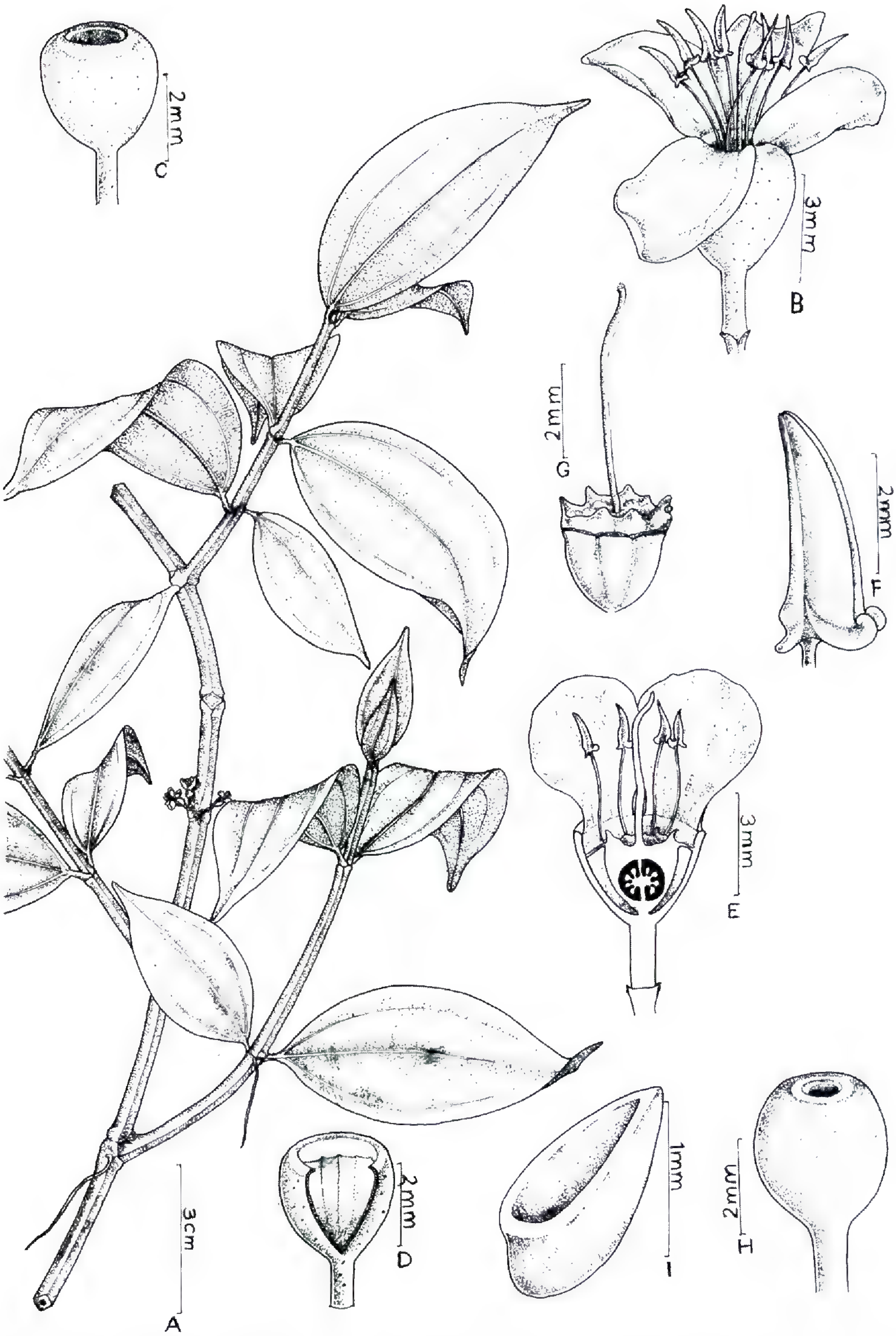


FIG. 1. *Medinilla anamalaiana* Sasidharan & Sujanapal. A. flowering twig; B. flower; C. hypanthium; D. hypanthium cut open; E. flower L.S; F. anther; G. pistil; H. fruit; I. Seed.

Flowering and Fruiting.—January–June.

Etymology.—The specific epithet of the new species is derived after its type locality, the Anamalai hills.

Distribution and Status.—The species is so far restricted to the evergreen forests, with an altitude ranges from 400–1300 m in the windward side of Anamalai hills.

Habitat and Ecology.—An epiphyte in the crevices of trees in the middle stratum of evergreen forests. This species is often found associated with epiphytes like *Aeschynanthus perrottetii* A. DC. Common tree associates are *Gymnanthemum arborea* (Buch.-Ham.) H. Rob, *Elaeocarpus glandulosus* Wall. ex Merr., *Turpinia malabarica* Gamble, *Drypetes wightii* (Hook. f.) Pax & Hoffm., *Palaquium ellipticum* (Dalz.) Baill., *Calophyllum polyanthum* Wall. ex Choisy, *Mesua thwaitesii* Planch. & Triana, etc.

PARATYPES: **INDIA. Kerala. Palakkad District:** Parambikulam Wildlife Sanctuary, Puliyala 1000 m, 3 Apr 2000, *P Sujanapal 30043* (KFRI). **Pathanamthitta District**: Goodrical Range, *Moozhiyar* 500 m, 23 May 1984, *N Sasidharan 3142* (KFRI). **Idukki District:** Periyar Tiger Reserve, Vallakkadavu 900 m, 3 Jun 1995, *Jomy Augustine & KP Rajesh 15429* (KFRI).

KEY TO SOUTH INDIAN SPECIES OF *MEDINILLA*

1. Flowers in horizontal rows or on 1–2 mm long peduncle; petals 5–7 × 4 mm _____ **M. anamalaiana**
1. Flowers in pedunculate cymes; peduncle 5–12 mm long; petals 10–14 × 8–10 mm.
   2. Leaves orbicular, fleshy; branchlets 2–3 mm thick, climbing _____ **M. beddomei**
   2. Leaves elliptic or elliptic-oblong, subcoriaceous; branchlets more than 5 mm thick, not climbing, clump forming.
      3. Petiole 4–7 mm long; lateral nerves arises from the base of the lamina _____ **M. malabarica**
      3. Leaves sessile or subsessile; lateral nerves arises ca. 2 mm above the base of the lamina _____ **M. fuchsioides**

ACKNOWLEDGMENTS

We are grateful to Wildlife Wing of Kerala Forest Department for the financial assistance; Director, Kerala Forest Research Institute, for providing facilities and Wildlife Wardens and Staff of the Parambikulam Wildlife Sanctuary and Periyar Tiger Reserve. Sincere thanks are also due to J.F. Veldkamp, Rijksherbarium, Leiden for critical comments and Latin diagnosis; V.B. Sajeev for illustrations. The first author is thankful to E. Nic Laughadha, Kew Herbarium for the help rendered in referring the relevant *Medinilla* specimens.

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BOOK REVIEWS

DENNIS W. WOODLAND. 2000. **Contemporary Plant Systematics. Third Edition.** (ISBN 1-883925-25-8, hbk.). Andrews University Press, 213 Information Services Building, Berrien Springs, MI 49104-1700, 616-471-6134. (Orders: aupress@andrews,edu. http://www.andrews.edu/press). Price not given, 569 pp., numerous line drawings, 7" × 10 1/2".

Contemporary Plant Systematics is written with the undergraduate or serious amateur botanist in mind. Often texts on this subject are directed at a graduate audience and are more rigorous and contain less "practical" information. Too often this subject is misunderstood and just a black box of "use less" information to the layperson. Dennis opens this box to view by including such practical topics as: basic rules for constructing and using dichotomous keys, a how-to on collecting, handling, and preserving specimens, and the role of botanical gardens in society. I really liked the chapter on pre serving plant diversity that included such topics as: value of plant species to humans, how species become endangered, genetic engineering and biodiversity, and how you can help endangered wild plants. And finally, an epilogue on the relevance of systematics to society ending with the most practical of all: job opportunities and qualifications. The book stays true to its title and includes the im portant contemporary topics of phylogenetics and molecular systematics. Of course, the bulk of the book deals with the classification of vascular plants beginning with the Pteridophytes. Dennis has been careful to include groups from around the world to give a less North American-centric view of the vascular plant kingdom with each group illustrated with botanical line drawings. My complaint with the text is this: though it contains few photographs they are all in black and white. This gives the text a rather outdated appearance. Though the text comes with a CD photo atlas of 4,700 color images I feel a more contemporary text layout would benefit this text.—*Robert J. George, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., rgeorge@brit.org*

KATHRYN BERNICK. 1998. **Basketry & Cordage from Hesquiat Harbour.** (ISBN 0-7718-0525-9, pbk.). Royal British Columbia Museum, P.O. Box 9815 Stn Prov. Govt, 675 Belleville Street, Victoria, British Columbia, VSW 9W2, Canada. $14.95, 152 pp., 114 figures, 6" × 9".

The Hesquait are a subdivision of the people of the Northwest Coast Culture Area and are related to the aboriginal inhabitants. The study of the plant-fiber artifacts from eight separate sites on the shores of Hersquait Harbor was undertaken as part of a larger project to reconstruct burial practices and site use over time.

The author has meticulously described and illustrated by drawings all the techniques of manufacture of the recovered artifacts, and the material composition and plant names are given. In addi tion there are photographs of the actual objects, which are classified by use. Finally, there is a comprehensive discussion of the findings and implications for further study.

This is not a book for the general reader or primarily for botanists, but the depth and clarity of the work make it a valuable addition to the library of archaeologists, anthropologists, and basketry enthusiasts.—*Ruth Ginsburg, Fort Worth, Texas.*

NEW TAXA OF *CRATAEGUS* (ROSACEAE) FROM THE NORTHERN OKANAGAN–SOUTHWESTERN SHUSWAP DIVERSITY CENTER

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ABSTRACT

Five new species and one new variety of *Crataegus* (Rosaceae) are described for the northern Okanagan area of British Columbia. They are *C. castlegarensis* (ser. *Douglasianae*), *C. shuswapensis* (? ser. *Douglasianae*), and *C. okanaganensis* var. *wellsii*, *C. enderbyensis*, *C. orbicularis* and *C. atrovirens* (all ser. *Purpureofructi*). This generates a rich western North American center of diversity for *Crataegus*, with 13 species so far known from this newly recognized center. Four of the species described here are endemic to the northern Okanagan but *C. castlegarensis* ranges widely to northern Oregon, northeastern Utah and western Montana while *C. okanaganensis* var. *wellsii* extends into the Okanogan of Washington. All the new taxa are illustrated and mapped. Revised keys for the relevant series are provided.

KEYWORDS: *Crataegus*, Rosaceae, new taxa, systematics, Okanagan, diversity center.

RESUMEN

Se describen cinco especies nuevas y una variedad de *Crataegus* (Rosaceae) en el norte de la región de Okanagan en la Columbia Británica. Son *C. castlegarensis* (ser. *Douglasianae*), *C. shuswapensis* (? ser. *Douglasianae*), y *C. okanaganensis* var. *wellsii*, *C. enderbyensis*, *C. orbicularis* y *C. atrovirens* (all ser. *Purpureofructi*). Esto genera un centro de diversidad rico en el oeste de Norte América para *Crataegus*, con 13 especies conocidas hasta el momento en este nuevo centro. Cuatro de las especies descritas aquí son endémicas del norte de Okanaga pero *C. castlegarensis* llega hasta el norte de Oregón, noreste de Utah y oeste de Montana, mientras que *C. okanaganensis* var. *wellsii* se extiende por el Okanoga de Washington. Todos los nuevos taxa se ilustran y cartografían. Se aportan claves revisadas para las series relevantes.

The northern Okanagan of British Columbia and the southwestern part of the adjacent Shuswap drainage is the richest area for *Crataegus* in North America west of the Rocky Mountains. In addition to the five new species described here, there are another three (Phipps & O'Kennon 1998) recently described species (*C. okennonii* J.B.Phipps, *C. okanaganensis* J.B.Phipps & O'Kennon and *C. phippsii* O'Kennon), as well as four long-ago described species, *C. chrysocarpa* Ashe (incl. *C. piperi* Britton = *C. columbiana* Howell, sens. auctt.), *C. macracantha* Lodd. ex Loud., *C. douglasii* Lindl., *C. suksdorfii* (Sarg.) Kruschke, plus the introduced *C. monogyna* Jacq., for a total of 13 species. This is enough to recognize a local diversity

center for *Crataegus* (Fig. 1), by far the richest in western North America for an area of this size. This diversity center is mapped in more detail in Fig. 2 where many of the collection localities cited in this paper can be located. The contrast with earlier understanding of *Crataegus* in British Columbia is striking. T.M.C. Taylor (1973) listed only three species for the province, the native *C. douglasii* and *C. columbiana* and the introduced *C. monogyna*, although the illustration labelled *C. columbiana* is clearly *C. macracantha* as we have noted previously (Phipps 1998).

The native hawthorns of the Okanagan-Shuswap belong to a diverse range of series, not necessarily particularly closely related to one another, viz.: *Douglasianae*, *Purpureofructi*, all the species of which occur in the region, and *Macracanthae* and *Rotundifoliae* (sens. auctt.). The reasons for this rich variety of hawthorn in the northern Okanagan and southwestern Shuswap drainage cannot be spelled out precisely but presumably relate to the location of former glacial refugia, as well as the benign climate. It is, of course, clear that wherever the relevant refugia were at a given time they must have been constantly relocated by changes of Pleistocene climate. In this mountainous region, hawthorns are virtually restricted to the valley bottoms, become rarer southwards (the southern Okanagan is much drier) and are nearly absent from the forest environment of the middle slopes. In the somewhat mesic area of the northern Okanagan, which is the area of greatest natural diversity, natural hedgerows dominated by hawthorns are a feature of the agricultural landscape and hawthorns also occur along smaller watercourses and ditches as well as forming downslope hillside thickets in some moister sites. The annual rainfall here is around 500–600 mm but falls off to about 200 mm in the southern Okanogan.

In this paper we describe the new taxa *C. castlegarensis* (ser. *Douglasianae*), *C. shuswapensis* (? ser. *Douglasianae*), *C. okanaganensis* var. *wellsii*, *C. orbicularis*, *C. enderbyensis* and *C. atrovirens* (all ser. *Purpureofructi*). Updated keys are produced for the series in question. All species are illustrated with line illustrations. Distribution maps of the new taxa were created by Range-Mapper (Tundra Vole Software, Fairbanks, AL) from files of latitude-longitude coordinates and then artistically improved by Susan Laurie-Bourque using Corel Draw. The discoveries are the result of several years of fieldwork by the authors in the mid-1990s and 2001–2 plus further discoveries in 2000 by the first author with his wife Sheila and son William. The collections of May, 2002 substantially increase the number of flowering specimens previously available for study and from which the cited material derives.

TAXONOMY

In this part we set out the new taxa in the context of others in the same series by providing a key to series and references to descriptions of the already known

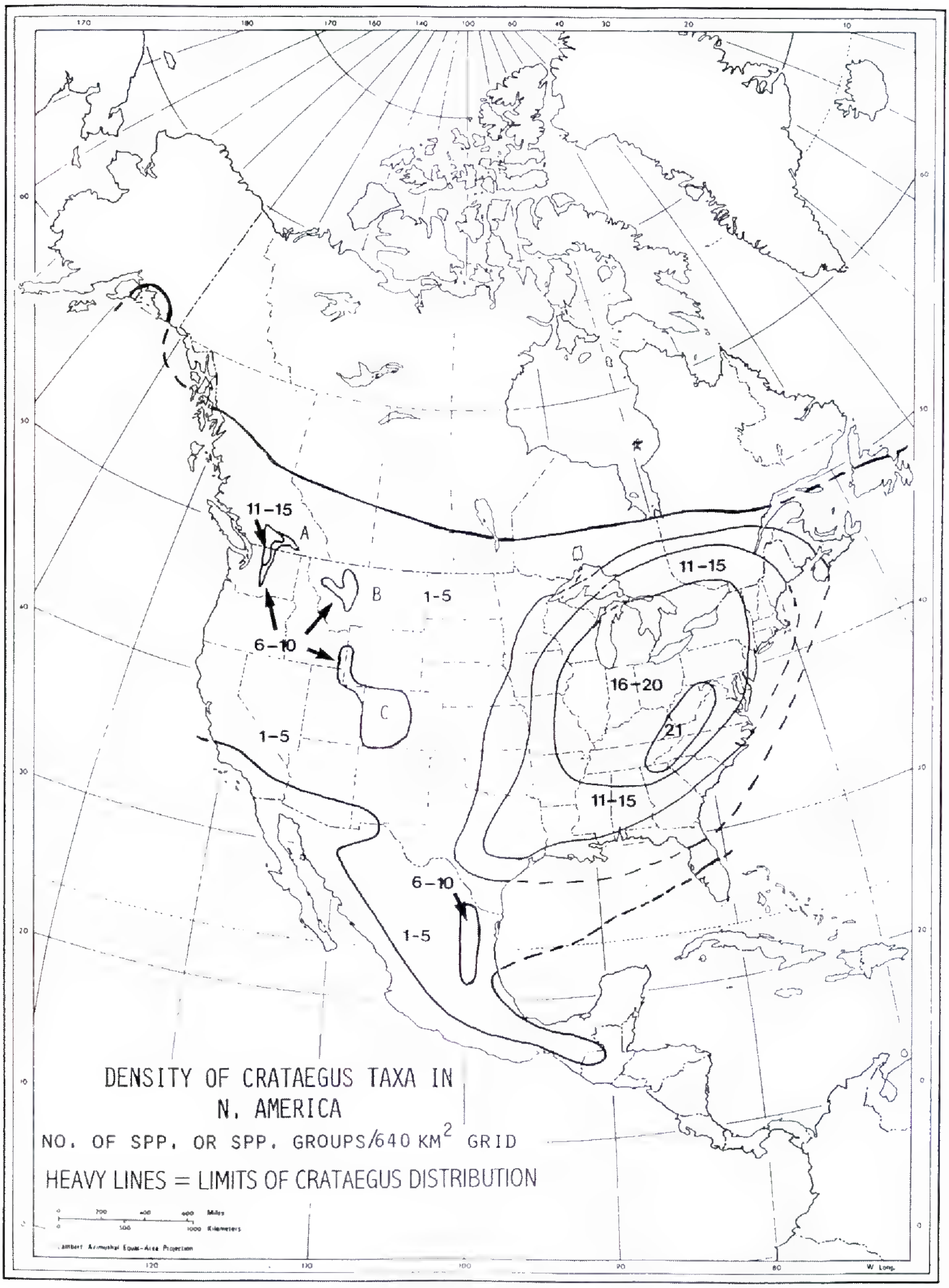


FIG. 1. Locator map for the Okanagan diversity center. Diversity centers indicated are: A = northern Okanagan–southwestern Shuswap; B = northwestern Montana; C = intermountain Colorado.

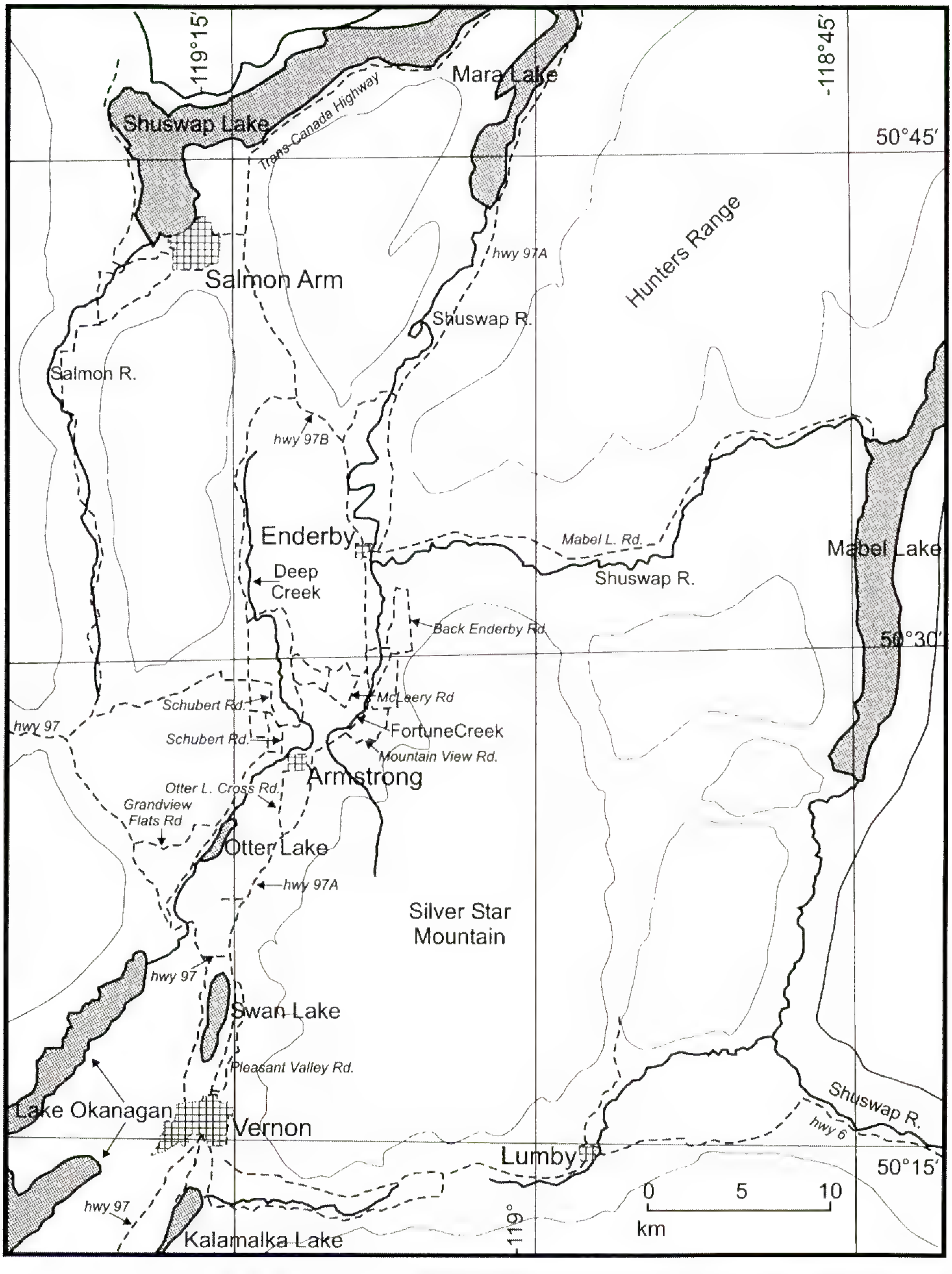


FIG. 2. Detail map of the Okanagan-Shuswap diversity center with its epicenter at Enderby. Unlabelled lines are 500m contours. Use for locating specimens of *Crataegus enderbyensis*, *C. orbicularis*, *C. shuswapensis* and *C. atrovirens*.

species in these series. In the cases of *C. douglasii*, which has been much confused with other hawthorns in the area, and *C. suksdorfii*, both of which, as far as we know, lack modern, detailed species descriptions, we also provide full English descriptions. We also provide amended series descriptions. The depth of lobing of leaves is referred to by term 'leaf incision index' or 'LII' ('IFI' in latin).

Series **Douglasianae** (Rehder ex C.K. Schneid.) Rehder.

Bushes to small trees; 1-year old wood generally tan to deep purple-brown; thorns mostly 1.5–2.5 cm long, dark and shiny when young. Leaves deciduous; petioles fairly short; blades 3–5(–7) cm long, broadly elliptic or elliptic to somewhat obovate in general shape, shallowly (0–)2–3 lobed per side, the lobes obtuse to subacute; margins toothed; venation craspedodromous to nearly fully camptodromous in some unlobed forms; petioles and leaf teeth tips somewhat glandular. Inflorescences 8–20 flowered; branches glabrous or pubescent, bracteolate; anthesis early. Flowers 12–18 mm diam.; calyx-lobes subentire, small; stamens 10 or 20, anthers pink; styles 3–5. Fruit smallish, 0.6–1.0 cm long, ellipsoidal to subspherical, black or dark purple at full ripeness, hairy or glabrous; nutlets 3–5, dorsally furrowed, lateral faces pitted.

This is a small series of ± widespread 'black-fruited' hawthorns of the northwestern USA and adjacent Canada with four species, one of which, *C. douglasii*, extends to the Great Lakes area. Series *Douglasianae* are notable for their laterally pitted nutlets, short thorns and dark purple to black fruits at full maturity in which they resemble Eurasian ser. *Nigrae*. We add one new species to this group and amend the key.

KEY TO SPECIES

1. Stamens 20; leaf-blades often unlobed, if lobed, lobes generally obtuse to subacute; when lobeless venation semi-camptodromous _____ **1. C. suksdorfii**
1. Stamens 10; leaf-blades usually lobed; lobes of leaves subacute to acute; venation craspedodromous.
   2. Inflorescence branches glabrous; thorns on twigs always single; fruit longer than broad, generally chestnut, dark purple or black in late August.
      3. Thorns 2–3.5 cm long; flowers 12–15 mm diam.; fruit ellipsoid, usually deep purple or even black by late August, very bloomy at this time _____ **2. C. douglasii**
      3. Thorns 1.5–2 cm long; flowers 15–18 mm diam.; fruit ampulliform, chestnut or burgundy in late August, generally not very bloomy _____ **3. C. okennonii**
   2. Inflorescence branches and hypanthium ± pubescent; thorns on twigs occasionally paired or in triads; fruit subglobose to depressed, passing through crimson lake (purplish-crimson) to burgundy in late August _____ **4. C. castlegarensis,** sp. nov.

1. Crataegus suksdorfii (Sarg.) Kruschke, Milwaukee Public Mus. Public. Bot. 3:163. 1965.

Crataegus douglasii Lindl. var. *suksdorfii* Sarg., Bot. Gaz. 44:65. 1907.

Bushes, often 3–5 m tall, perhaps larger; one-year old twigs tan, older grayish; thorns 1.5–2.5 cm long, recurved or straight, glossy dark brown when young.

Leaves deciduous; petioles 0.75–1.5 cm long, glabrous, eglandular westwards, in Montana glandular; blades ± rhomb-elliptic to ellipt-obovate in general shape, 3–6 cm long, tapered to the base, unlobed to irregularly sharply to very bluntly 2–3 lobed per side; margins toothed, the teeth in Montana glandular; venation craspedodromous to semi-campdodromous in blunt-lobed western specimens; appressed hairy above, ± glabrate below except pubescent near the veins in Oregon. Inflorescences 7–15 flowered, branches glabrous, punctate, bearing small, early caducous, linear, membranous, gland-margined bracteoles. Flowers ca. 15–17 mm diam.; hypanthium glabrous externally; calyx-lobes ca. 4 mm long, triangular, abaxially glabrous, margins minutely and sparingly glandular-serrate; petals ± circular, white; stamens 20, anthers pink; styles 4–5. Fruit 1 cm long, subglobose to broad-ovoid in the few specimens seen, black at maturity, dull vinous purple a month before; calyx-lobes reflexed; nutlets 4–5, dorsally grooved, sides erose.

Crataegus suksdorfii occurs mainly along the coast and ranges from California northwards to Vancouver Island, the Queen Charlotte Islands and coastal Alaska to around Anchorage. It is also scattered sporadically inland east to Montana. *Crataegus suksdorfii* is by far the most northerly occurring *Crataegus* in North America at 61° N lat. It is diploid according to Brunsfeld and Johnson (1990).

In the relatively few specimens I have studied, the fruit is smaller and more globose than in *C. douglasii*. It is most convincingly differentiated from *C. douglasii* by stamen number and perhaps by fruit shape and early color, but like *C. douglasii*, it also has a variety of leaf shapes and a venation type which lie generally outside the range of that species. The glandular leaf-teeth and petiole make the Montana specimens distinct. Some of the deeply dissected, pointed lobed, ± delt to rhomb-ovate leaved forms from the western US appear very distinctive.

2. Crataegus douglasii Lindl., Bot. Reg. 21: pl. 1810. 1835.

Crataegus columbiana Howell, Fl. Northw. Amer. 1:163. 1898.

Bushes 4–6 m tall, thorny; thorns ± stout, 1.5–3.5 cm long, straight or slightly recurved, deep brown and shiny when young; one-year old twigs deep tan to dark mahogany, somewhat shiny when young, older branches gray to dark gray, often showing brown or alternatively tan-brown eastwards. Leaves deciduous; petioles 0.75–1.5 cm long, slightly glandular and pubescent in youth; blades 4–7 cm long × 2–3 cm wide, somewhat variable in shape but generally elliptic to broad-elliptic or sub-rhombic, generally with 2–4 coarse lobes per side, alternatively elliptic-obvate with much smaller lobes; margins coarsely and sharply toothed, the teeth tipped with small glands when young; venation craspedodromous with 4–5 lateral veins per side; quite densely appressed short-pubescent above, below usually glabrous except on the veins. Inflorescences 10–25 flowered; branches usually glabrous, bearing caducous, membranous,

linear, gland-margined bracteoles. Flowers 12–15 mm diam.; hypanthium externally glabrous; the calyx-lobes very short, 3–4 mm long, fairly broad triangular, adaxially glabrous, the margins with a few tiny glands distally; petals ± circular, white; stamens 10, anthers pink; styles 3–4. Fruit 6–8 mm diam., ellipsoid, dull black when fully ripe, though vinous when younger, generally very bloomy until maturity; calyx-lobe remnants short, blunt, reflexed; nutlets 3–4, dorsally grooved, laterally excavated.

Douglas hawthorn is a common, somewhat variable bush of southern and western British Columbia up to the panhandle of Alaska which ranges south to northern California (Shasta Co.) and inland to the Rocky Mountains of Idaho, Montana and sw Alberta. Further east, disjunct populations occur in the Cypress Hills (AB & SK), Black Hills (WY & SD), and around the northern Great Lakes. In western North America *Crataegus douglasii* is found mainly near water in drier areas but in more mesic localities in a good variety of open woodland. In the Great Lakes area it mainly occurs in old pastures and on fence lines.

Crataegus douglasii is distinguished from *C. suksdorfii* which has 20 stamens, semi-camptodromous venation and little lobed, ± obtuse leaves, and from the taller *C. okennonii* which has generally shorter thorns, usually straight single trunk, ampulliform-orbicular fruit and crimson-lake autumnal foliage color. *Crataegus douglasii* is mainly tetraploid (Brunsfeld et al. 1990).

3. Crataegus okennonii J.B. Phipps, Sida 18:170. 1998.

This species commenced flowering 10–14 days later than *C. douglasii* in the northern Okanagan in 2002.

4. Crataegus castlegarensis J.B Phipps & O'Kennon, sp. nov. (**Fig. 3**). TYPE: UNITED STATES. IDAHO. Lemhi Co.: US 93, E side, 14.5 rd. mi N of Salmon, roadside ditch next to irrigated field, alt. ca. 3950 ft, bush, 5 m tall, foliage dull, dark, coriaceous, fruit strongly clustered, red-burgundy, with short pedicels, 20 Aug 1996, *J.B. Phipps & O'Kennon 7396* (HOLOTYPE: UWO; ISOTYPES: BRIT, CAN, MO, MONTU, TRT, UBC, V, WS).

Frutices, 2.5–5.0 m alti, uno vel pluribus truncis erectis; rami patentes; ramuli unius anni brunnei; spinae 2–3 cm longae, mediana crassitudine, rectae vel leviter recurvatae, nitenter atrobrunneae, apice atro in juventute. Folia decidua; petioli 0.75–1.5 cm longi, varie pilosi, eglandulosi; laminae 3.5–6.0 cm longae, oblanceolatae vel ovato-rhombeae in forma generali; apex late triangularis, basis late cuneata vel cuneata; vix lobatae vel 3–4 lobatae per latus; aliquantum coriaceae; venatio craspedodroma, 4–5 nervatae per latus; margines serrati; facies adaxialis conspicue appresso-pilosa in juventute, aliquantum glabrescens in vena centrali, abaxialis rare pubescens vel glabra venis exceptis. Inflorescentiae 8–20 florae; pedicelli leviter vel dense pubescentes, bracteolis caducis, linearibus, membranaceis, glandulo-marginatis. Flores ca. 12–15 mm diam.; hypanthium plerumque glabrum extrinsecus; lobi calycis 3 mm longi, triangulares, paene glandulo-serrati; petala ± circularia; stamina 10, antheris roseis; styli 3–4. Fructus 10–12 mm diam., orbiculares aliquantum oblati, recedentes in juncturis cum pedicellis, sparsim pilosi, carmesini vel coloris pruni rubentis et postremo atropurpurei; lobi calycis patento-reflexi, ± erosi; pyrenae 3–4, dorsaliter sulcatae, superficiebus lateralibus plerumque foveolatis.

Shrubs, 2.5–5.0 m tall with one or more erect stems; branches spreading; 1-year old twigs brown; thorns 2–3 cm long, of medium stoutness, straight to slightly

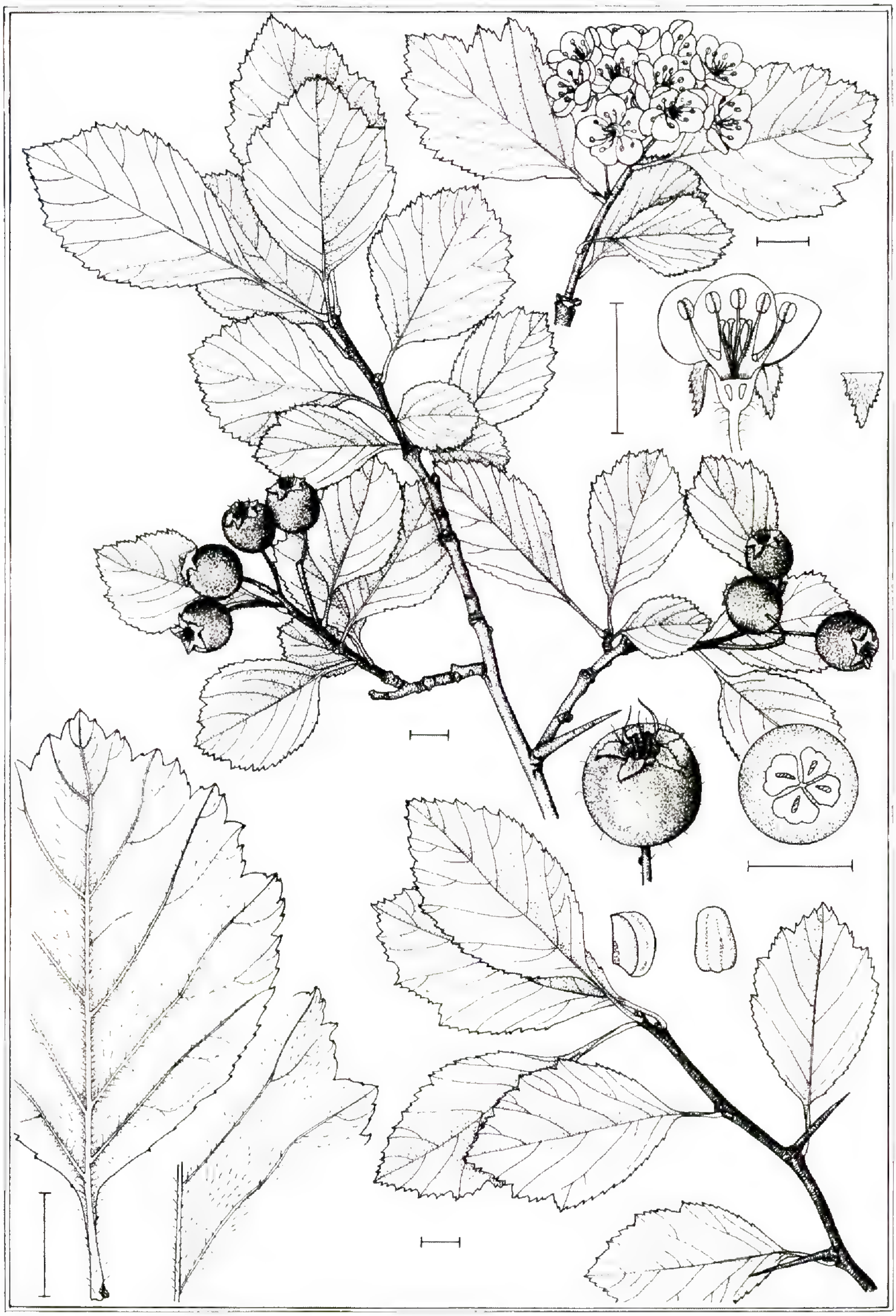


FIG. 3. Line drawing of *Crataegus castlegarensis*. Scale bars = 1 cm.

recurved, shiny dark or reddish-brown with blackish tips when young. Leaves deciduous; petioles 0.75–1.5 cm long, eglandular, variably hairy; blades 3.5–6.0 cm long, oblanceolate to ovate-rhombic in general shape; the tip broad-triangular, base broad-cuneate to cuneate; scarcely lobed to 3–4 lobed; margins toothed, teeth with fine gland-tips when young; venation craspedodromous, each side 4–5 nerved; conspicuously appressed hairy above when young, somewhat glabrescent except on the mid-nerve above, thinly pubescent to glabrous below except on the veins, somewhat coriaceous. Inflorescences 8–20 flowered; branches thinly to densely pubescent, bearing caducous, linear, membranous, gland-margined bracteoles. Flowers ca. 12–15 mm diam.; hypanthium generally glabrous externally; calyx lobes 3 mm long, triangular, remotely glandular-serrate; petals ± circular; stamens 10, anthers pink; styles 3–4. Fruit 10–12 mm diam., ± orbicular, often somewhat oblate, recessed at junction with pedicel, thinly pilose, crimson turning to reddish-plum or ultimately blackish purple; calyx-lobes patento-reflexed, + erose; nutlets 3–4, dorsally grooved, lateral faces usually pitted.

Crataegus castlegarensis has a wide range (Fig. 4) from the John Day (South Fork) R. basin of Oregon and the Okanagan of British Columbia eastwards to the Flathead drainage of northwestern Montana, thence south down the mountains to northeastern Utah and west-central Wyoming. We have also recently recorded it from the Cypress Hills of Alberta and Saskatchewan but those specimens are not cited. It is most abundant north of Kelowna, British Columbia and in the Flathead drainage in Montana and is found in brushy places in the valleys, particularly near ditches and natural waterways. Fine specimens of this species occur on the grounds of Selkirk College, Castlegar, British Columbia, where several were collected for us by Peter Wood, then a professor at that institution. It was here that the authors first became aware of the distinctness of this taxon and we are pleased to name it after the town of Castlegar.

Like a good number of *Crataegus* species from the Pacific Northwest *C. castlegarensis* has been collected but overlooked and the few specimens that we have encountered other than our own collections have been variously assigned to *C. douglasii* and *C. columbiana*. *Crataegus castlegarensis* is apparently the most closely related of ser. *Douglasianae* to *C. douglasii*. It differs in the fruit shape (± orbicular/turbinate in *C. castlegarensis*; ellipsoid in *C. douglasii*), fruit color at comparable period of ripening (often dull plum blotched green early, then burgundy to crimson, finally deep purple and not very bloomy in *C. castlegarensis*; starting about the third week of August as for the former species, usually already full black and remaining very bloomy unless abraded in *C. douglasii*); inflorescence branches and hypanthium, also, often fruit, proximally (pubescent to dense pubescent in *C. castlegarensis*; glabrous in *C. douglasii*). Pubescence of parts may abrade through the season and one may have to look

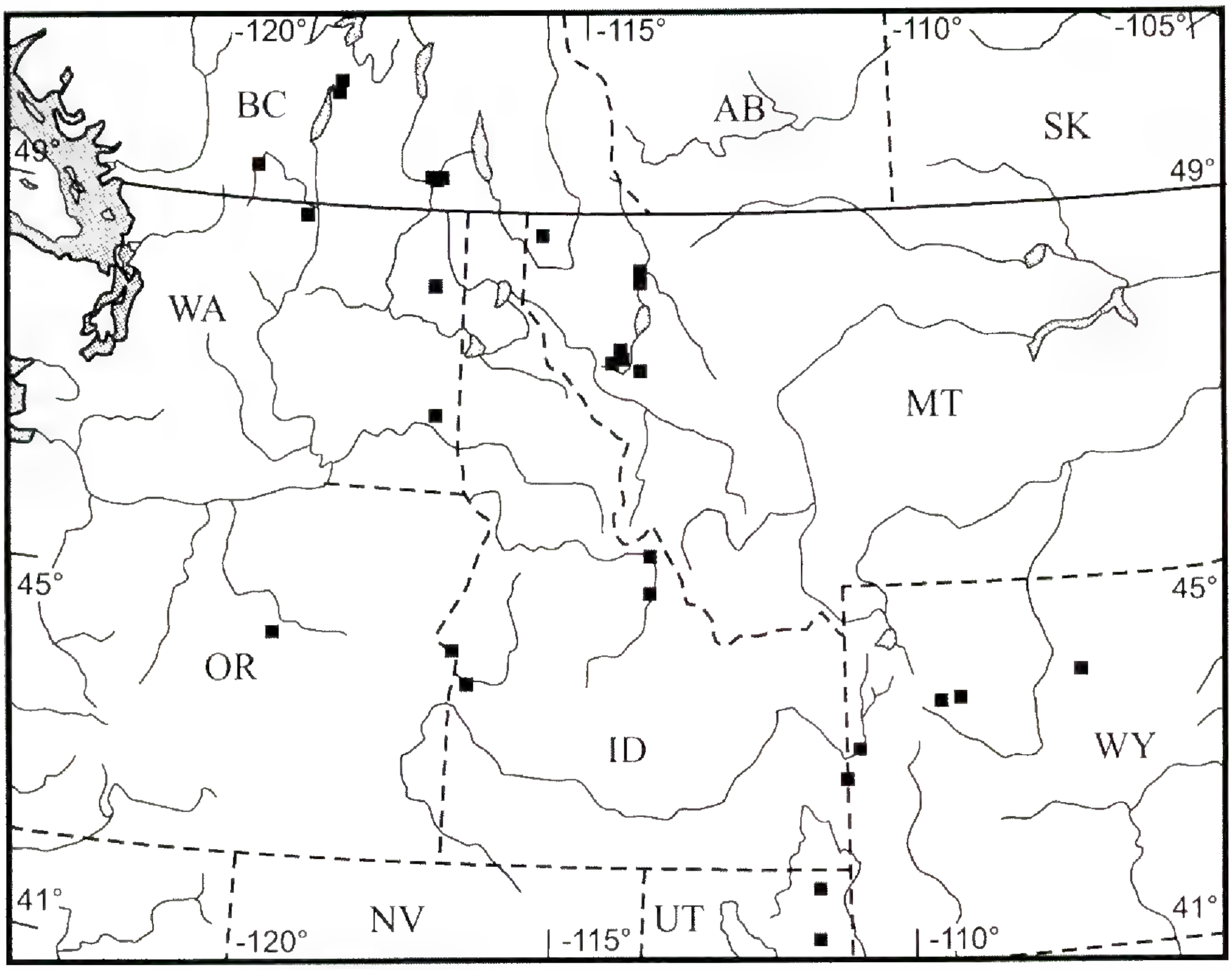


FIG. 4. Distribution map of *Crataegus castlegarensis* from collated records.

very carefully to discern it on fruiting pedicels. The junction of the fruit to the pedicel, often recessed like an apple, is also a characteristic of the new species. It came into flower about a week later than *C. douglasii* in the northern Okanagan in 2002.

A very interesting feature that we record is branched thorns (double to quadruple) on the young twigs. This feature is not known to us in other hawthorns except for the mutation of *C. monogyna*, cv. Horrida and occasional specimens of *C. enderbyensis*. On some of the bushes this multiple thorniness was abundant, in others more sporadic. We did not deliberately collect for this feature, indeed were not conscious of its relationship with *C. castlegarensis* early on, so it is possible that a more thorough check in the field of many of the collected bushes may have yielded more material like this. Branched thorn specimens are asterisked in the list of exsiccatae.

Additional specimens examined: **CANADA. BRITISH COLUMBIA:** Castlegar, N side of Frank Beinder Drive, ca. 10 ft down the embankment below the roadway, alt. 1550 ft, slender hawthorn, thorns 2.5–2.7 cm long, anthers creamy pink, 15 May 1995, *Peter Wood 1* (UWO). Castlegar, top of Frank Beinder Rd. to Selkirk College, opposite airport, scrubby small ravine, alt. 487 m, bush, 5 m tall, narrow-lanceolate leaves & obtuse lobes, purple fruit in dense clusters, 26 Sep 1993, *J.B. Phipps & R.J. O'Kennon*

*6823** (BRIT, CAN, ID, MONTU, RM, UBC, UT, UWO, V). Pleasant Valley Rd. NNE of Vernon, E side of road, ca. 0.5 mi N of Vowle's property, in bottom of ravine in apple orchard, 5 m bush, black fruit, 3-forked thorns, 25 Sep 1993, *J.B. Phipps & R.J. O'Kennon 6818** (BRIT, UWO). Castlegar, Selkirk College, top of wooded steep slope near Peter Wood's office, alt. 1000 ft, collection of different leaves from 4 m bush, 27 Sep 1993, *J.B. Phipps & R.J. O'Kennon 6825* (UWO). Okanagan Valley, ca. 8 km NNE of center of Vernon, Pleasant Valley Rd., behind Vowle's residence, hedge at S boundary of Burke's PYO, alt. 380 m, dense, broad, mature hedge dominated by hawthorns, bush 2.5 m tall, anthers 10, pink, 02 May 1994, *J.B. Phipps 6881** (BRIT, UBC, UWO). Kalamalka L. Provincial Park, along road ca. 25 m SW of red gate, brushy roadside, alt. ca. 1450 ft, bush, 5 m tall, fruit burgundy turning black, foliage large (equals *JBP 6888*), 18 Aug 1994, *J.B. Phipps & R.J. O'Kennon 6980** (UWO). Northern Okanagan, Kalamalka Provincial Park, roadside near red gate, bush, 6 m tall, fruit burgundy, ± spherical to short turbinate, locally abundant, 26 Aug 2000, *J.B. & S.R. Phipps 8187** (UWO). Castlegar, top of Frank Beinder Rd. to Selkirk College, opposite airport in bottom of scrubby roadside ravine, alt. +87 m, bush, 5 m, stamens 5, anthers small, pink, (=*JBP & RO'K 6823*), 06 May 1994, *J.B. Phipps 6925* (UBC, UWO). Castlegar, top of Frank Beinder Rd. to Selkirk College, opposite airport, bush 2 m tall, half-way up slope before 'curve road' sign, stamens 5, anthers pink, 06 May 1994, *Phipps, J.B. 6926* (UWO). 6.7 rd. mi SW of Princeton on BC3, edge of Typha marsh on SE side of hwy, alt. 2800 ft, bush, 3.5 m tall, fruit orbicular, burgundy, beginning to be taken by waxwings, lvs thin, coriaceous, shiny (=*JBP & RO'K 6774*), 17 Aug 1994, *J.B. Phipps & R.J. O'Kennon 6972* (BRIT, CAN, MONTU, TRT, UBC, UWO, V). Castlegar, Frank Beinder Drive, scrubby slopes with aspens, ca. 250 m E of campus gate, alt. 1550 ft, tree, 6 m tall, fruit ± orbicular, reddish-plum to deep purple, 23 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7053* (BRIT, UBC, UWO). Castlegar, Frank Beinder Drive, scrubby slopes with aspens, ca. 75 m E of campus gate & behind pine, alt. 1550 ft, bush 2 5 m tall with purple-black globose fruit, 23 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7055* (BRIT, UBC, UWO). Castlegar, Frank Beinder Drive, opposite airport entrance, at top of little ravine virtually within reach of road, alt. 1600 ft, bush, 5 m tall, fruit orbicu lar, turning burgundy from reddish plum, 23 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7054* (BRIT, UWO, V). Ca. 8 road mi SW of Princeton on BC3, edge of large dried up marsh on E side of hwy, bush 10 ft tall, leaves reddish, fruit black-burgundy, 23 Sep 1993, *J.B. Phipps & R.J. O'Kennon 6774* (UWO). Salmon Arm, large hawthorn pasture just N of railroad and west of central business section, alt. ca. 1900 ft, bush, 4 m tall, fruit deep burgundy, ± spherical, 20 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7030* (UWO). Vernon, Y Lake, open aspen grove near pond, 10 May 1970, *T.M. Brayshaw & D. Laidman s.n.** (UWO, V) [numerous triple and quadruple thorns—J.B.P.].

U.S.A. IDAHO: Lemhi Co.: US 93, 4 mi S of 45° N lat sign and 18 road mi S of Salmon, 4600 ft, gravelly banks of Salmon R, bush 5 m tall, 17 May 1997, *J.B. Phipps & R.J. O'Kennon 7532* (BRIT, UT, UWO); US 93, 17.5 mi S of Salmon, brushy banks of Salmon R., bush, 4 m tall, flowers 16 mm diam., 17 May 1997, *J.B. Phipps & R.J. O'Kennon 7535* (BRIT, ID, UWO); US 93, 14.5 mi N of Salmon, E of side road, fenceline against pasture, alt. 4300 ft, bush, 5 m tall, inflorescence very pubescent, tight cluster of flowers, flowers diameter greater than or equal to 15 mm, anthers 10, pink, some paired thorns, (equals *JBP 7396*), 17 May 1997, *J.B. Phipps & R.J. O'Kennon 7537** (BRIT, ID, MONTU, UWO); US 93, 17 rd. mi N of Salmon, brushy banks of South Fork, Salmon R., alt. 3900 ft, bush 4 m tall, 17 May 1997, *J.B. Phipps & R.J. O'Kennon 7540* (BRIT, ID, MONTU, UT, UWO); US 93, at bottom of gravel slope near Salmon River, ca. 18 rd. mi S of Salmon and ca. 4 mi S of 45° N lat. sign, alt. 4600 ft, several-stemmed bush 5 m tall, frt. variably ripe: green light red dull red-burgundy, + oblate-spherical, with marked depression at pedicel, lvs coriaceous, blue-green, broad, lobed, frt. in dense clusters, short pedicels, small green bracteoles, 20 Aug1996, *J.B. Phipps & R.J. O'Kennon 7394* (BRIT, ID, MONTU, UT, UWO); US 93, 8 mi N of Salmon, 2.5 mi S of Tower Creek, in field, alt. ca. 4300 ft, dense bush, 4 m tall, leaves narrow-obovate, blue-green, somewhat cupped, fruit orbicular with recessed pedicel, green to dull red, 20 Aug 1996, *J.B. Phipps & R.J. O'Kennon 7395* (ID, UT, UWO); US 93, 17.4 rd. mi N of Salmon, west side, roadside ditch, alt. 3900 ft, bush, 2 m tall, fruit dull purple-red, 20 Aug 1996, *J.B. Phipps & R.J. O'Kennon 7397* (UWO). Payette Co.: Hwy. 53 roadside, in floodplain of Payette River, ca. 9 rd. mi SE of

Payette, alt. 2300 ft, slightly swampy fields, 27 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7094* (UWO) **Washington Co.:** US 95 at Monroe Creek, ca. 5.6 mi N of Weiser (MP 88.4), alt. ca. 2700 ft, brushy area, bush, 5 m tall, fruit large, spherical, red changing to burgundy, 27 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7095* (BRIT, ID, MONTU, RM, UT, UWO). **MONTANA: Flathead Co.:** Hwy 35, ca. 0.5 mi SE of Creston, alt. 3050 ft, dense bush 3 m tall, fruit orbicular, dull red, 25 Aug 1994, *J.B Phipps & R.J. O'Kennon 7071* (MONTU, RM, UWO). Junction of state road 35 and unpaved road to Fish Hatchery, small hawthorn thicket in old pasture, alt. ca. 2800 ft, bush, 3 m tall, flowers at popcorn, anthers pink, 20 May 1997, *J.B. Phipps & R.J. O'Kennon 7589* (MONTU, UWO). Flathead River Valley, 1 mi E of 206, ca. 3 mi SE of Columbia Falls center on dirt extension of S end Berne (Jensen) Rd., 3100 ft, large 6 m bush near pond, (=*JBP & RO'K #6838*), stamens 10, anthers pink, coll. 8 May, buds forced, 08 May 1994, *J.B. Phipps 6938* (BRIT, ID, MONTU, RM, UBC, UWO). Flathead River Valley, 1 mi E of 206, 3 m SE Columbia Falls center at extreme S end of Jensen Rd., by pond, alt. 3100 ft, 5 m bush, fruit orbicular, purple-black, 27 Sep 1993, *J.B. Phipps & R.J. O'Kennon 6838* (BRIT, ID, MONTU, RM, UBC, UWO). **Lake Co.:** State Road 35 E of Polson, between Turtle Lake Road and Ducharme, Indian Agency lands with stream, mature ponderosa pine and mown grass, along water edge, alt. 2950 ft, bush, 6 m tall, twigs with some bi-thorns, in bud, anthers pale pink, 19 May 1997, *J.B. Phipps & R.J. O'Kennon 7581** (UWO); Old Freight Rd., off US 93 W of St. Ignatius, hawthorn thickets in creek beds between dry grassland, at roadside, alt. 2900 ft, bush 4 m tall, leaves rhomb ovate, little lobed, badly rusted, fruit broad-ampulliform to suborbiculate, red to purple-black, common, Aug 21 1996, *J.B. Phipps & R.J. O'Kennon 7409* (BRIT, MONTU, RM, UWO); Old Freight Rd., off US 93 W of St. Ignatius, hawthorn thickets in creek beds between dry grassland, at roadside, alt. 2900 ft, bush, 4 m tall, leaves rhomb-ovate, little lobed, badly rusted, fruit broad-ampulliform to suborbiculate, red to purple-black, common, 21 Aug 1996, *J.B. Phipps & R.J. O'Kennon 7410* (UWO); ca. 0.5 km up Old Freight Rd. from US 93, hawthorn thickets along creek, alt. 3000 ft, 17 May 1997, *J.B. Phipps & R.J. O'Kennon 7552* (MONTU, UWO); Old Freight Road off Hwy 93, within sight of Hwy 93, milepost 30.4, 3 mi N of Ravalli, 10 pink anthers, 15–22 flowers per inflorescence, pedicels pubescent, calyx glabrous, medium thorns, 18 May 1995, *R.J. O'Kennon 13162* (UWO); Old Freight Road off Hwy 93, within sight of Hwy 93, milepost 30.4, 3 mi N of Ravalli, 17–22 flowers per inflorescence, 10 pink anthers, pedicels pubescent, calyx glabrous, looks like 13162, 18 May 1995, *R.J. O'Kennon 13164* (UWO); Old Freight Road off Hwy 93, within sight of Hwy 93, milepost 30.4, 3m N of Ravalli, 17–22 flowers per inflorescence, 10 pink anthers, full flower, pedicels and calyx pubescent, 18 May 1995, *R.J. O'Kennon 13165* (UWO). **Lincoln Co.:** Hwy 93, between Roosville & Eureka, W side of rd., ca. 1.0 mi N of junction with 37, seepage slopes below irrigation channel, on hillside, alt. 2850 ft, bush 4 m, crus-galli like foliage, frt. orbicular, crimson changing to burgundy, 24 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7062* (BRIT, MONTU, UWO). **Sanders Co.:** Banks of Little Bitterroot R. near confluence with Flathead R., alt. 2700 ft, bush 4 m tall, fruit ± orbicular, deep red, 21 Aug 1996, *J.B. Phipps & R.J. O'Kennon 7418* (ID, MONTU, UWO); 7 km direct NE of center of Camas Prairie Basin on road from Little Bitterroot Valley, close to Schmilz Lookout access road, seepage zone in prairie, alt. 3000 ft, bush, 4 m tall, anthers 10, pink, 18 May 1997, *J.B. Phipps & R.J. O'Kennon 7576* (BRIT, MONTU, UWO); at Little Bitterroot R., at eastbound road crossing exactly 20 km SE of Hot Springs, Evan Melton ranch, thickets at edge of water, alt. ca. 2800 ft, bush, 4 m tall, anthers 10, pink, 18 May 1997, *J.B. Phipps & R.J. O'Kennon 7571* (BRIT, MONTU, RM, UWO). Ca. 24 km (direct) SE of Hot Springs, hawthorn thickets along banks of Little Bitterroot R., alt. 2800 ft, bush, 3 m tall, anthers 10, pink, 18 May 1997, *J.B. Phipps & R.J. O'Kennon 7570* (BRIT, MONTU, RM, UWO); ca. 24 km (direct) SE of Hot Springs, hawthorn thickets along banks of Little Bitterroot R., alt. 2800 ft, bush, 3 m tall, anthers 10, pink, 18 May 1997, *J.B. Phipps & R.J. O'Kennon 7569* (BRIT, ID, MONTU, UT, UWO); hawthorn thickets with pasture along Little Bitterroot R., ca. 24 km SE of Hot Springs, Melton Sr. (grandfather) ranch, alt 2750 ft, bush 3 m tall, leaves broad, fruit burgundy, orbicular, Aug 21 1996, *J.B. Phipps & R.J. O'Kennon 7423** (UWO); hawthorn thickets with pasture along Little Bitterroot R., ca. 24 km SE of Hot Springs, Melton Sr. (grandfather) ranch, alt 2750 ft, bush 3.5 m tall, foliage intermediate, fruit burgundy, orbicular, 21 Aug 1996, *J.B. Phipps & R.J. O'Kennon 7425*

(BRIT, UWO); banks of Little Bitterroot R. ca. half mi S of confluence with Flathead R., bush 3 m tall, 18 May 1997, *J.B. Phipps 7561 & R.J. O'Kennon** (MONTU, UWO); hawthorn thickets along bank of Little Bitterroot R., abt 24 km direct SE of Hot Springs, 2800 ft, bush, 3 m tall, 18 May 1997, *J.B. Phipps & R.J. O'Kennon 7566* (BRIT, MONTU, UWO); hawthorn thickets along bank of Little Bitterroot R., abt 24 km direct SE of Hot Springs, 2800 ft, bush, 3 m tall, 18 May 1997, *J.B. Phipps & R.J. O'Kennon 7568* (BRIT, MONTU, UWO); crossing of Little Bitterroot R. exactly 20 km SE of Hot Springs, thickets at edge of water, Evan Melton ranch, 2800 ft, bush 4 m tall, 18 May 1997, *J..B. Phipps & R.J. O'Kennon 7573* (BRIT, MONTU, RM, UWO); main road SE from Hot Springs along Little Bitterroot River at 5 mi due N of major NS/EW bend (near location of *7420*) at Malinak mailbox, alt 2800 ft, two hawthorns along ditch on west side of road, healthy bush, 4 m tall, 21 Aug 1996, *J.B. Phipps & R.J. O'Kennon 7427* (UWO); Hot Springs-Perma Rd., Camas Prairie Basin, ca. 4 mi S of Camas Prairie, alt. 2850 ft, large bush 6 m tall, fruit burgundy-red, 21 Aug 1996, *J.B. Phipps & R.J. O'Kennon 7429* (UWO); Little Bitterroot River at eastbound road crossing exactly 20 km SE of Hot Springs, road from Hot Springs to Evan Melton ranch, alt. 2790 ft, open thicket of hawthorns in pasture near creek, bush 3 m tall, leaves blue-green, fruit deep burgundy, orbicular, with recessed pedicel, locally frequent, 21 Aug 1996, *J.B. Phipps & R.J. O'Kennon 7420* (MONTU, RM, UWO). **OREGON: Grant Co.:** John Day Valley, S fork, Humphreys, small tree, 30 Apr 1925, *L.F. Henderson 5146** (CAS, DS, photo UWO). **UTAH: Cache Co.:** S of Hyrum Reservoir at 7800, off 400S, fenceline, S side of dirt road, alt. 4800 ft, bush, 5 m tall, small flowers, 10 pink anthers, 15 May 1997, *J.B. Phipps & R.J. O'Kennon 7528* (BRIT,ID,UT,UWO); E side of south end of Hyrum Reservoir across field from intersection of 7000W and 400S, hedgeline, alt. 4800 ft, bush, 4 m tall, flowers small, anthers 10, deep pink, 15 May 1997, *J.B. Phipps & R.J. O'Kennon 7527* (BRIT, ID, MONTU, NY, RM, UBC, US, UT, UWO). **Weber Co.:** Huntsville, on N side of UT 39 ca. 0.5 mi after it turns E of Pineview Reservoir, roadside with ditch backing irrigated fields, bush, 6 m tall, but early, white, forced, 10 pink anthers, 4 green styles, inflorescences more floriferou-s and dense than *C. rivularis*, 15 May 1997, *J.B. Phipps & R.J. O'Kennon 7526* (UWO); UT 39 ca. 1/2 mi after it turns E, E of Pineview Reservoir, roadside with ditch (water flowing) backing on to irrigated field, 2 adjacent bushes, ca. 6 m tall, densely foliaged, lvs. blue-green, young twigs & thorns shiny olive-brown, frt. orbicular, recessed at pedicel contact, green turning light to dull red to vinous to black, on same tree, 18 Aug 1996, *J.B. Phipps & R.J. O'Kennon 7389* (BRIT, ID, MONTU, RM, UT, UWO); ravine to E of S.R. 167 (Trappers' Loop Rd.), along creek, alt. 5200 ft, bush 4 m tall, abundant, 22 May 1997, *J.B. Phipps & R.J. O'Kennon 7608* (BRIT, MONTU, UT). **WASHINGTON: Okanogan Co.:** Chopaka Rd., 2.75 mi from Loomis-Nighthawk Rd. junction, 28 Aug 1994, *J.B. Phipps 7106 & R.J. O'Kennon* (UWO). **Spokane Co.:** S of Deer Park, 0.5 mi S of milepost 179 on US 395, 30 Sep 1993, *J.B. Phipps 6861 & R.J. O'Kennon* (UWO). **Whitman Co.:** Staley Rd., 2 km NE of Chambers, floodplain of small creek, dense small tree 4 m tall, fruit orbicular, red changing to burgundy, 27 Aug 1994, *J.B. Phipps 7097 & R.J. O'Kennon** (BRIT, UBC, UWO, WS, WTU). **WYOMING: Lincoln Co.:** US 89, S of Thayne and 0.4 mi N of Salt River, floodplain pastures with hawthorn thickets, alt. 5950 ft, bush, 4 m tall, inflorescence pubescent, anthers 10, pink, in green bud, forced, 21 May 1997, *J.B. Phipps & R.J. O'Kennon 7597** (BRIT, MONTU, RM, UWO); US 89 S of Thayne at 0.4 mi N of Salt River crossing, fenceline in flood plain, alt. 5950 ft, bush, 3.5 m tall, (– JBP 7462), in tight bud, forced, 16 May 1997, *J.B. Phipps & R.J. O'Kennon 7531** (RM, UWO); US 89, S of Thayne and 0.4 mi N of Salt R. crossing, 2.5 mi N of junction with 238, fencelines in floodplain, alt. 5950 ft, bush, 3.5 m tall, leaves deep green, somewhat lobed fruit red to plum-red, orbicular, held erect, 25 Aug 1996, *J.B. Phipps & R.J. O'Kennon 7462* (BRIT, UWO). **Teton Co.:** Targhee National Forest, US 89, 5.4 mi S of Hoback Jct., flats of Snake River, alt. 6200 ft, dense brushy area with tall trees of cottonwood and pine, bush, 6 m tall, foliage narrow, fruit spherical, colors greenish to red to plum to burgundy, 25 Aug 1996, *J.B. Phipps & R.J. O'Kennon 7460* (BRIT, MONTU, RM, UT, UWO). Targhee National Forest, flats of Snake R., 5.4 mi S of Hoback Jct., alt. 6200 ft, 21 May 1997, *J.B. Phipps 7593a* & R.J. O'Kennon* (UWO). **Washakie Co.:** US 16, 1 mi E of Tensleep, river flats of Tensleep R., in sagebrush country, alt. 4550 ft, bush, 4 m tall, badly rusted, leaves thin, (one bush was non-rusted), fruit suborbicular, plum-colored, 24 Aug 1996, *J.B. Phipps & R.J. O'Kennon 7456* (UWO).

Incertae Sedis

Crataegus shuswapensis J.B. Phipps & O'Kennon, sp. nov. (**Fig. 5**). TYPE: CANADA: BRITISH COLUMBIA: Northern Okanagan, Enderby, ca. 200 m E of bridge over Shuswap River on Mabel Lake Rd., bush, 3.5 m tall, fruit deep purple (=*JBP 6910*), 20 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7009* (HOLOTYPE: UWO; ISOTYPES: BRIT, CAN, DAO, TRT, UBC).

Frutices ad 5 m alti; ramuli unius anni glandulacei vel atrobrunnei; spinae 2–3 cm longae, ± validae, rectae vel leviter recurvatae, in juventute atrobrunneae. Folia decidua; petioli 1.5–2.25 cm longi, sparsim glandulo maculati, leviter pubescentes; laminae 5–7 cm longae, rhombeae in forma generali, lobis acutis, ca. 4-lobatae per latus, cum IFI ad 25%; venatio craspedodroma, venis secondariis 4–5 per latus; margines remote serrati; facies adaxialis aliquantum appresso-pubescens, abaxialis glabra. Inflorescentiae 12–18 florae; ramuli glabri, cum nonnullis bracteolis caducis linearibus, glandulo-marginatis. Flores ca. 15 mm diam., hypanthium extrinsecus glabrum; lobi calcycis 4–5 mm longi, triangulares, minute glandulo-marginati; petala circularia; stamina 10(15–18), antheris pallide vel clare roseis vel rare tyriis; carpelli et styli 2–3. Fructus 12 mm longi, ± late-ellipsoidei, in juventate roseo-vinosi, atropurpurei in maturitate; reliquiae calycis adsunt, patento-recurvatae; pyrenae 2–3, dorsaliter sulcatae, in lateribus planae.

Bushes to 5.5 m tall; one year old twigs tan to deep brown; thorns 2–3 cm long, stoutish, straight or slightly recurved, very dark brown when young. Leaves deciduous; petioles 1.5–2.25 cm long, sparsely gland-dotted, slightly pubescent; laminas 5–7 cm long, rhombic in general shape; ca. 4-lobed per side, LII to 25%; venation craspedodromous, with 4–5 pairs of secondary veins; lobes sharp; margins remotely serrate; somewhat sparsely appressed-pubescent above, glabrous below. Inflorescences 12–18 flowered, the branches glabrous, some linear caducous gland-margined bracteoles present. Flowers ca. 15 mm diam.; hypanthium glabrous externally; calyx-lobes 4–5 mm long, triangular, minutely gland-margined; petals circular; stamens 10(15–18), anthers pale to bright pink or rarely puce; carpels and styles 2–3. Fruit ± broadly ellipsoidal, 12 mm long, claret color at first, deep purple at maturity; calyx remnants present, patento-recurved; nutlets 2–3, grooved dorsally, smooth on sides.

Crataegus shuswapensis is locally common near Enderby in the northern Okanagan and southwestern Shuswap drainage, British Columbia. Collection localities may be identified, at least approximately, on figure 2.

This is a very distinctive hawthorn on account of its rhombic, wide and quite deeply and sharply lobed leaf-blades, stamens with anthers pink or sometimes puce and fairly large suborbicular to broad-ellipsoid purple fruit. The flowers, and to some extent the fruit, are much like *C. douglasii* but other characteristics, the rather long stout thorns, leaf shape, fruit color about the third week in August, 2–3 styles and nutlets point in a different direction. Flowering material with 10 pink stamens from near Polson, Montana, may be the same and fruiting specimens are required to verify this. This species flowers synchronously with *C. castlegarensis* in the northern Okanagan.

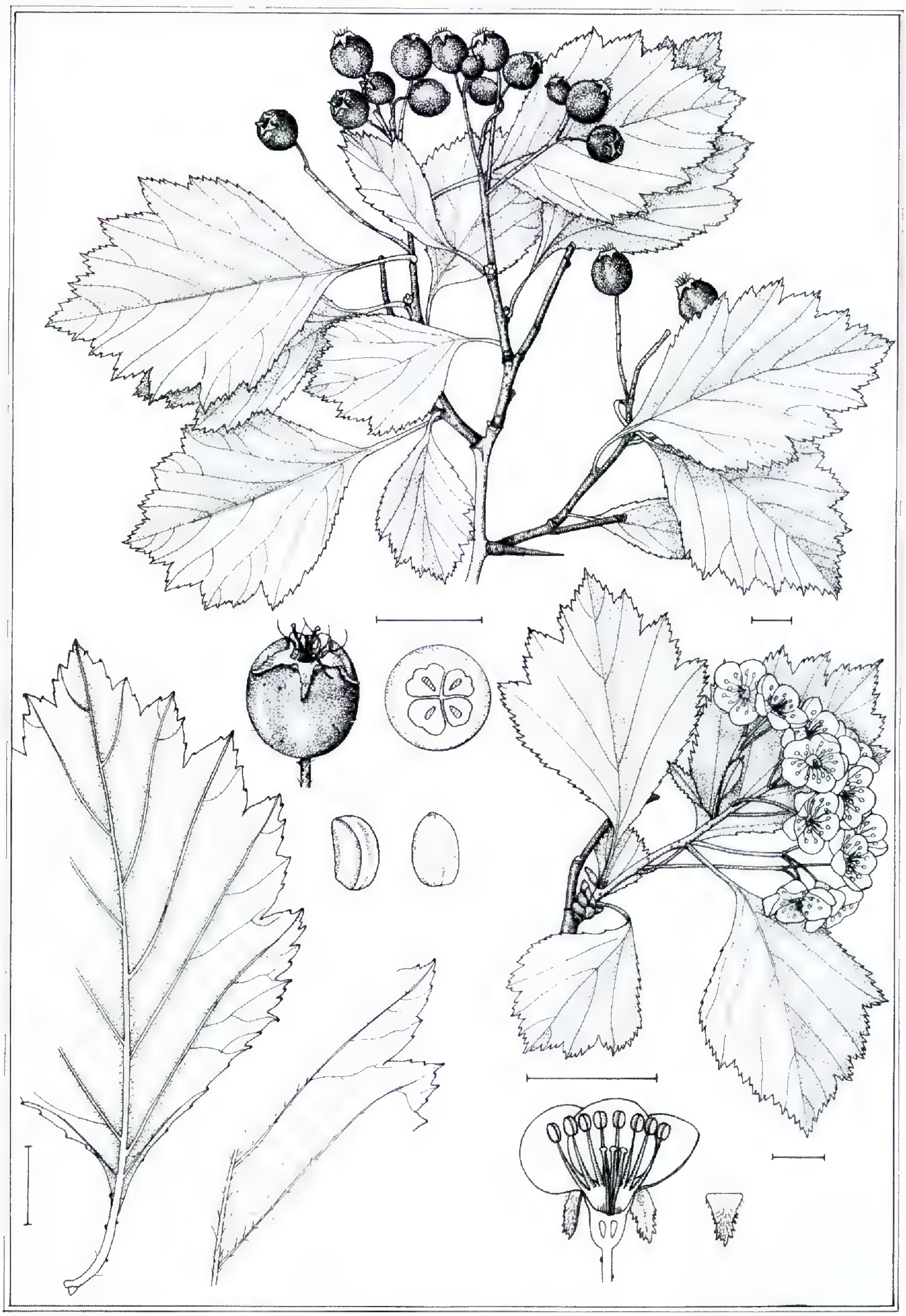


FIG. 5. Line drawing of *Crataegus shuswapensis*. Flower details illustrate rare 15 stamen form. Scale bars = 1 cm.

Additional specimens examined: **CANADA. BRITISH COLUMBIA:** Valley of the Shuswap, 8.0 km E of Enderby, little to E of Brash Creek, road-edge, woodland S side of road, shade, alt. 1270 ft, 4 m tall large bush in shade of balsam poplar, black fruit, 20 Aug 1995, *J.B. Phipps 7172* (UWO); Northern Okanagan, Spallumcheen Municipality, Marshall Road (dead end gravel drive off Mcleery Rd.), alt. 1300 ft, bush, 2.5 m tall, fruit deep plum-purple, ellipsoid, 20 Aug 1995, *J.B. Phipps 7169* (BRIT, UBC, UWO, V); Mabel L. Rd., N side, ca. 150 m E from Shuswap River bridge, 3–3.5 m tall, anthers exhibit slight pink tinge, 15 May 1995, *L.S. & D. Donovan 2755* (UWO); Near Enderby, S end of 97A, E side of Hwy 97A, ca. 150 m from Mabel L. Rd., forest margin, alt. ca. 1250 ft a.s.l., ca. 2.5 m tall, 15–18 pink anthers, spindly, leaves larger, lighter green (shady location?), 15 May 1995, *L.S. & D. Donovan 2754* (UWO); Near Enderby, S end of 97A, E side of Hwy 97A, ca. 150 m from Mabel L. Rd., forest margin, alt. ca. 1250 ft a.s.l., ca. 3 m tall, anthers pink to red, 15–18 stamens, 15 May 1995, *L.S. & D. Donovan 2753* (UWO); S end of 97A, near Enderby, E side of Hwy 97A, ca. 150 m from Mabel L. Rd., forest margin, alt. ca. 1250 ft a.s.l., ca. 1.75 m tall, 15–18 stamens, deeply lobed leaves, anthers pink, 15 May 1995, *L.S. & D. Donovan 2752* (UWO); Rd. to Mabel L. ca. 1.2 mi E of Enderby and between 25 m and 200 m W of "Autobody collision and repairs" sign, hedgerow, alt. 1275 ft, bush 3 m tall, fruit burgundy-red, 20 Aug 1994, *J.B. Phipps & R.J. Okennon 7015* (BRIT, UWO); 1.25 mi E of Enderby on Mabel L. Rd., ca. 200 m E of "Autobody Collision, Repairs & Painting" sign, 1275 ft, hedgerow, bush, 5.5 m tall, 20 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7018a* (BRIT, UWO); Shuswap Valley, ca. 8 km E of center of Enderby on road to Kingfisher, S side of road, 1270 ft, hedge backing small woodlot, bush, 4 m tall, stamens 10, anthers pink, (*=JBP & RO'K 6815*), 05 May 1994, *J.B. Phipps 6922* (BRIT, CAN, UBC, UWO, V); Shuswap Valley, road to Kingfisher, ca. 2 km E of Enderby, opposite sign on N, "Autobody Collision, Repairs & Painting", alt. 1275 ft, hedgerow S side of road, bush 5 m, ca. 18 puce anthers, (*probably = JBP & RO'K 6810*), 05 May 1994, *Phipps, J.B. 6917* (BRIT, UBC, UWO); Shuswap valley, just E of Enderby, across bridge, N side of road at edge of swamp forest, alt. ca. 1250 ft, bush, 3 m tall, thorns medium, dark green foliage, stamens 15, anthers pale pink, 05 May 1994, *J.B. Phipps 6910* (BRIT, UWO); Northern Okanagan, Spalumcheen Municipality, Stepney Cross Rd., lowest point, large bush, 4 m tall, 26 Aug 2000, *J.B. Phipps 8182 & S.R. Phipps* (UWO).

ser. **Purpureofructi** J.B. Phipps & O'Kennon.

Bushes or small trees, generally 3–6 m tall; thorns 2–5 cm long, slender to quite stout, shiny dark brown to purple or black at 2 yrs, usually quite numerous; extending twigs thinly pubescent or glabrous; at 1 year deep reddish-brown or mahogany, older dark gray. Leaves deciduous; petioles 1/4–1/2 length of blade, 1–3 cm long, eglandular or with some small black glands, glabrous to thinly pubescent while young; blades 3–8 cm long, ± rhombic to elliptic-oblong, ovate-rhombic or occasionally suborbiculate in general shape; acute at the apex, cuneate to somewhat rounded at the base; 1–3(–4)-lobed per side, the lobes obscure and shallow to well-defined and acute and with max. LII ca. 20%; margins serrate except at the base, the teeth with small gland-dots; venation craspedodromous, 4–6(–7) per side, ± impressed in the more coriaceous-leaved species; usually scabrate-pubescent on the upper surfaces young, this variably glabrescent (abrading with age), below glabrous on the surface, pubescent or not on the veins; markedly coriaceous to thin; autumnal color generally brilliant. Inflorescences 8–25 flowered; branches glabrous or thinly pubescent, bearing caducous, membranous, linear, gland-margined bracteoles. Flowers 12–18 mm diam.;

hypanthium externally glabrous to pubescent; calyx-lobes 2–4 mm long, narrow, abaxially glabrous, margins finely glandular-serrate; petals ± circular, white; stamens (5)10–12, anthers white or pink; styles 2–4(–5). Fruit 8–10 mm diam., ± orbicular to ellipsoidal or ampulliform, mostly red in late August, deep purple or deep reddish-purple (often nearly black) in late September; calyx-lobes narrow or broad, reflexed to erecto-patent, thinly hairy to glabrous; nutlets 2–4(–5), dorsally furrowed, sides plane to quite deeply pitted.

Six species are now recognized, found from the Okanagan Valley of British Columbia and Washington east to northwest Montana. They are all locally common in suitable habitats. We add three new species and one variety to this series and emend the key.

These include some very handsome hawthorns, particularly in late summer and autumn when their usually abundant fruit turns from bright red to deep purple and the leaves manifest brilliant coloring in bronze, burgundy, yellow etc. These hawthorns have very high ornamental potential but are not yet cultivated outside botanic gardens and arboreta.

KEY TO SPECIES OF SERIES *PURPUREOFRUCTI*

1. Leaf-blades rhomb-elliptic to elliptic in general shape, lobes ± sharp.
   2. Calyx-lobes in fruit us.reflexed, if erecto-patent, very narrow; anthers pink or white; leaf- blades various but never suborbiculate, only rarely broad-elliptic.
      3. Anthers pink; anthesis later than *C. macracantha*; leaves thin; thorns somewhat slender _____ **1. C. williamsii**
      3. Anthers generally cream or white; anthesis with or somewhat before *C. macracantha*; leaves coriaceous; thorns usually ± stout.
         4. Leaf-blades 3.5–6 cm long, coriaceous, without strongly impressed venation above, flattish to strongly concave, generally mid-green until fall; hypanthium glabrous or hairy _____ **2. C. okanaganensis** [incl. var. **wellsii**]
         4. Leaf-blades 4–8 cm long, softly coriaceous, with distinctly impressed venation above, flattish to convex, generally deep green until fall; hypanthium glabrous _____ **3. C. enderbyensis**, sp. nov.
   2. Calyx-lobes in fruit sub-erect, broad, herbaceous; anthers pink; leaf blades elliptic to broad elliptic to suborbiculate, sometimes ovate.
      5. Leaf-blades elliptic to broad elliptic or suborbiculate; mid-green; fruit ca. 8 mm long, glabrous, oblong suborbicular reddish in August, plum in September; inflorescences glabrous _____ **4. C. orbicularis**, sp. nov.
      5. Leaf-blades elliptic to ovate in general shape, deep green; fruit 13–15 mm long, hairy, ampulliform to ellipsoid, deep burgundy in late August, nearly black in September; infloresences pubescent _____ **5. C. atrovirens**, sp. nov.
1. Leaf-blades broad-ovate to ovate elliptic in general shape, lobes subacute to obtuse _____ **6. C. phippsii**

1. Crataegus williamsii Eggl., Bull. Torrey Bot. Club 36:641. 1909. See also J.B. Phipps, Canad. J. Bot. 76:1889. 1998.

2. Crataegus okanaganensis J.B. Phipps & O'Kennon, Sida 18:178. 1998.

KEY TO VARIETIES

Leaf-blades 1.2–1.6 × as long as wide, sharply lobed; fruit flask-shaped ___ **2a.** var. **okanaganensis**

Leaf-blades 1.6–2 × as long as wide, shallowly lobed in distal half only or occasionally essentially unlobed; fruit subspherical ___ **2b.** var. **wellsii**, var. nov.

2a. Crataegus okanaganensis var. **okanaganensis**.

2b. Crataegus okanaganensis var. **wellsii** J.B. Phipps & O'Kennon, var. nov. (**Fig. 6**). TYPE: UNITED STATES: WASHINGTON: Okanogan Co.: Palmer Lake, N side; large bush, 5 m tall, stamens 5, anthers ivory, (equals *J.B.P. & R.J.O'K. 6875*), 4 May 1994, *J.B. Phipps 6905* (HOLOTYPE: UWO; ISOTYPES: BRIT, CAN, DAO, UBC, US, WS).

Frutices grandes vel arbores parvae ad 6 m alti, saepe cum truncis multiplicibus; ramuli unius anni atrospadicei; spinae 2–5 cm longae, in juventute nitenter atro-brunneae, validae, recurvatae. Folia decidua; petioli 1–1.5 cm longi, in juventute supra glandulosi saltem et pubescentes; laminae 3.5–5 cm longae, ellipticae vel ellipt-oblongae vel elliptico-rhombeae vel elliptico-ovatae in forma generali; saepe leviter contractae in petiolum vel cum basi obtusa; apices acutae; saepe ± cum lateribus ± parallelis in parte media; latera nonlobati vel lobis distinctis 1–3, latere distali anguli loborum plerumque + perpendiculari ad venam medianam; margines serratae; venatio craspedodroma, venis secondariis principalibus 4–5 per latus; facies adaxialis breviter appresso-serrata in juventute, abaxialis glabra venis exceptis. Inflorescentiae 8–15 florae; ramuli sparsim pilosi, bracteolis caducis, linearibus, membranaceis, glandulo-marginatis. Flores ca. 15 mm diam.; hypanthium supra glabrum et subter villosum; lobi calycis anguste-triangulares, tenuiter glandulosi; petala ± circularia; stamina (5–)10–12, antheris plerumque eburneis; carpelli et styli 2–3(–4). Fructus ca. 10 mm diam., ± orbiculares, subter pilosi, sanguinei in Augusto exeunte, in maturitate atropurpurei; lobi calycis triangulares, plerumque reflexi; pyrenae 2–3, dorsaliter sulcatae, lateribus planis vel vadositer foveolatis.

Large shrubs to 6 m tall, often with multiple trunks; 1 year old twigs mahogany; thorns 2–5 cm long, shiny dark brown when young, stout, recurved. Leaves deciduous; petioles 1–1.5 cm long, glandular above at least when young, pubescent when young; blades 3.5–5 cm long, elliptic or ellipt-oblong to elliptic-rhombic or elliptic-ovate in general shape; apex acute, base often slightly tapered into petiole or obtuse; often ± parallel-sided at broadest part, unlobed or with 1–3 distinct lobes, distal side of angle of lobes usually ± perpendicular to mid vein; margins serrate; venation craspedodromous with 4–5 main secondary veins per side; short-appressed serrate when young above, glabrous below, except along veins. Inflorescences 8–15 flowered; branches thinly hairy, with early caducous, glandular bracteoles. Flowers 15 mm diam.; hypanthium externally glabrous above and villous below; calyx-lobes narrow-triangular, finely glandular; petals ± circular; stamens (5–)10–12, anthers usually ivory; carpels and styles 2–3(–4). Fruit ca. 10 mm diam., ± orbicular, hairy below, dull deep red at late August, deep purple at full ripeness; calyx-lobes triangular, usually reflexed; nutlets 2–3, dorsally sulcate, sides plane or shallowly pitted.

Crataegus okanaganensis var. *wellsii* is found in the Okanagan valley of British Columbia and Washington and is common around Vernon (Fig. 7). Aboriginal people in Washington recognized this taxon as "stemoq'w" according to R. May's collection notes (cited specimen *May 258RM* from WA).

This variety was first collected by T.C. Wells at Kalamalka Provincial Park,



FIG. 6. Line drawing of *Crataegus okanaganensis* var. *wellsii*. Scale bar = 1 cm.

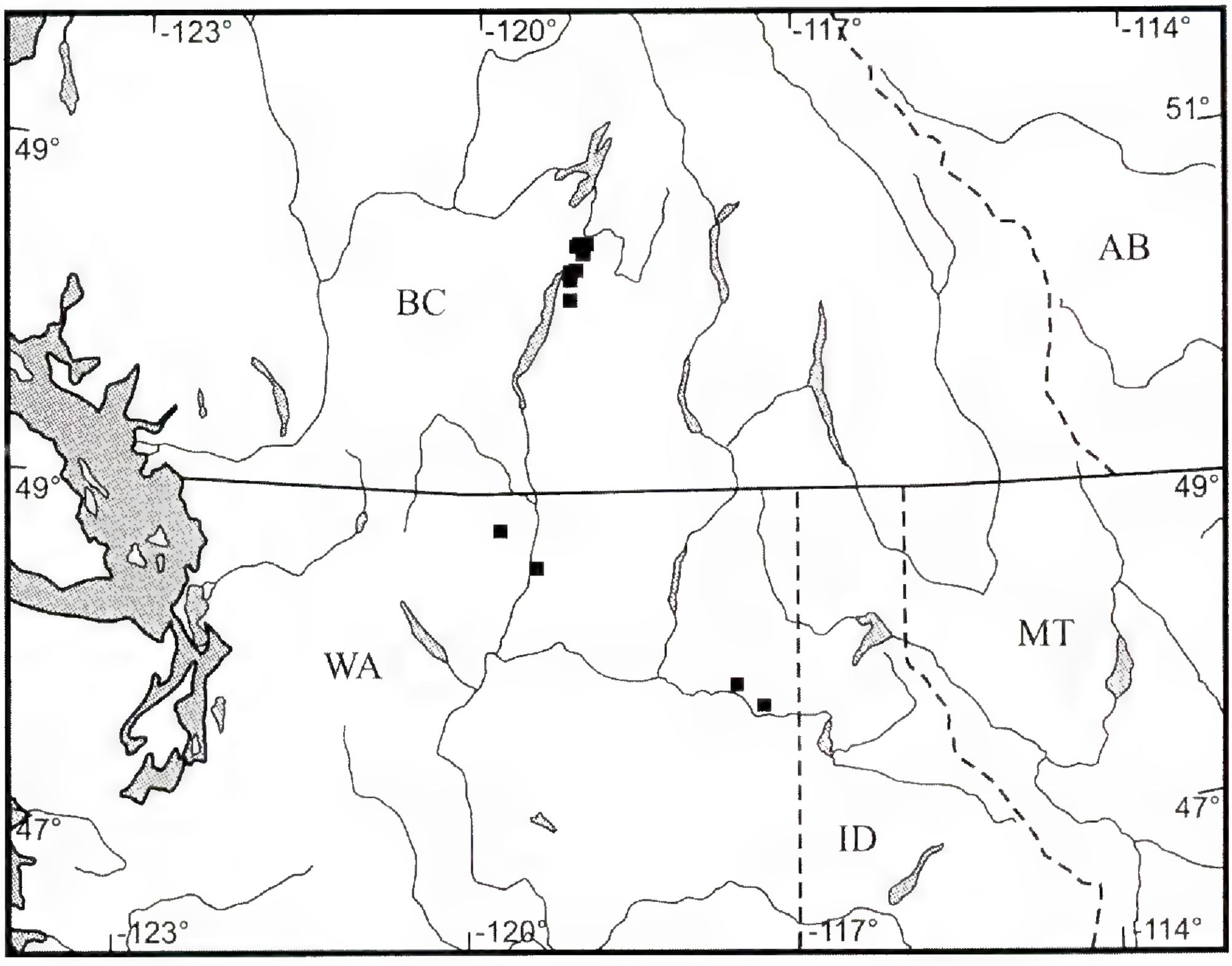


FIG. 7. Distribution map of *Crataegus okanaganensis* var. *wellsii* from collated records.

near Vernon. In its modal form it is very distinct with its unusual leaf-shape (quite differently lobed from var. *okanaganensis*). It also differs from var. *okanaganensis* in its orbicular fruit, fewer nutlets, fewer stamens (in the type), and crimson (or pink-burgundy) fall color versus copper-bronze in var. *okanaganensis*. Fruit may be a somewhat different color than nearby var. *okanaganensis* at the same time in late August, although in the third week of August they are brilliant scarlet. The most extreme form, virtually thornless, was seen at Palmer Lake, northern Washington. In spite of the several differences from var. *okanaganensis* the presence of intermediates prevents a higher rank.

Additional specimens examined: **CANADA. BRITISH COLUMBIA:** Ca. 10 km N of Vernon center on dirt road, N bound into O'Keefe ranch off 97A at L.& A. Cross Rd., boundary hedge along ditch, common component, 3.5 m bush, fruit burgundy, 25 Sep 1993, *J.B. Phipps & R.J. O'Kennon 6804* (UWO). Kalamalka Lake Prov. Park, 2 km SE of Vernon, at southern terminus of Kidston Road, alt. 440 m, in damp low-lying area, in open thicket, 5 m shrub, few thorns, 5 stamens, cream colored anthers), 16 May 1993, *T.C. Wells & M.E. Wells 1799* (UWO). Kalamalka Lake Prov. Park, 2 km SE of Vernon, at southern terminus of Kidston Road, alt. 440 m in damp low-lying area, in open thicket, 4 m shrub, 5 stamens, cream colored anthers, common, 16 May 1993, *T.C. Wells & M.E. Wells 1797* (UWO). Kalamalka Lake Prov. Park, 2 km SE of Vernon, at southern terminus of Kidston Road, alt. 440 m in damp low lying area, in open thicket, 4 m shrub, 5 stamens, essentially thornless, 16 May 1993, *T.C. Wells & M.E.*

Wells 1796 (UWO). Larry Calder property, E of 97, ca. 9 km NNE of Vernon, scrubby partly cleared hillside, alt. ca. 474 m, young 3 m bush, purple fruit, 26 Sep 1993, *J.B. Phipps & R.J. O'Kennon 6819a* (UWO). Okanagan Valley, ca. 10 km N of Vernon off 97A NW bound along dirt road into O'Keefe Ranch, at L. and A. Cross Road, alt. 1270 ft, boundary hedge along ditch, on SW side, bush, 4 m tall, stamens 10, anthers pale pink (=*J.B. Phipps & R.J. O'Kennon 6804*), 03 May 1994, *J.B. Phipps 6893* (UWO). Kalamalka Lake Provincial Park, ca. 10 km SSE of center of Vernon, near parking lot after yellow gate, alt. ca. 1375 ft, large bush 6 m tall, 5 ivory stamens, (= *J.B. Phipps & R.J. O'Kennon 6798*), 03 May 1994, *J.B. Phipps 6885* (TRT, UBC, UWO, V). Ca.10 km N of Vernon center on dirt road N into O'Keefe Ranch off 97A at L. & A. Cross Road, alt. 1270 ft, boundary hedge along ditch, common component, 3.5 m bush, fruit burgundy, 25 Sep 1993, *J.B. Phipps & R.J. O'Kennon 6805* (UWO). Shuswap Valley, just E of Enderby, across bridge, S side of road, top of river bank, alt. ca. 1250 ft, bush 4 m tall, in bud, stamens 5 or 10, anthers ivory, 05 May 1994, *J.B. Phipps 6914* (UWO). Kalamalka L. Prov. Park, 2 km SE of Vernon, Kidston Rd. entrance at red gate, with *Amelanchier alnifolia*, *Symphoricarpus albus*, *Pinus ponderosa*, open thickets, alt. 550 m, 4 m tree, shiny scarlet fruit, common, 18 Aug 1987, *T.C. Wells 689* (UBC # 19422, UWO). Kalamalka L. Prov. Park, 2 km SE of Vernon, Kidston Rd. entrance at red gate, with *Amelanchier alnifolia*, *Symphoricarpus albus*, *Pinus ponderosa*, open thickets: alt. 550 m, 4 m tree, shiny scarlet fruit, common, 18 Aug 1987, *T.C. Wells 690* (UBC # 194423, UWO). Shuswap Valley, just E of Enderby, across bridge, S side of road, top of river bank, alt. ca. 1250 ft, bush 4 m tall in late bud, stamens 10, anthers ivory, 05 May 1994, *J.B. Phipps 6915* (UWO). Kalamalka L. Prov. Park, 2 km SE of Vernon, at S terminus of Kidston Rd. red gate, with *Amelanchier alnifolia*, *Symphoricarpus albus*, *Pinus ponderosa*, open thickets, 550 m, 3 m shrub, heavily fruited, shiny, scarlet frt., common, *T.C. Wells 691* (UWO, UBC 194424); Aug 18, 1987. Shuswap Valley, just E of Enderby, across bridge, S side of road, top of river bank, alt. ca. 1250 ft, bush 6 m tall, in late bud, stamens 10, anthers ivory, 05 May 1994, *J.B. Phipps 6916* (UWO). Spallamcheen Municipality, E side 97A 1/2 mi N of intersection with 97, scrubby slopes rich in *Crataegus*, bush 6 m tall, red fruit, most abundant *Crataegus* here, 19 Aug 1994, *J.B. Phipps & R.J. O'Kennon 6999* (BRIT, UWO, V). Ca. 1 mi S of Enderby, N-trending, downslope gravel driveway bordered with hawthorns, alt. 1300ft, bush, 4 m tall, fruit burgundy, 20 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7006* (BRIT, UBC, UWO). Ca. 10 km N of Armstrong, W of Indian Reservation, alt. ca. 1550 ft, long farm drive with *Crataegus* hedgerow, bush 2 m tall, fruit in various stages of red, 21 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7035* (UWO). Okanagan Valley, Spallumcheen Municipality, L. & A. Cross Road, extreme E end, just W of Hwy 97A, alt. 1270 ft, along driveway N into farm, this species abundant here, shrub 4 m, rather dense fruit, blood-red, ± spherical, *J.B. Phipps 7161* (CAN, ID, TRT, UBC, UWO, V); Aug 17, 1995. Northern Okanagan, Spallumcheen Municipality, Otter Lake Cross Rd., just N of Hales Rd., 19 Aug 1995, *J.B. Phipps 7162* (TRT, UBC, UWO, V). Northern Okanagan, Spallumcheen Municipality, Marshall Rd., alt. 1300 ft, natural hedgerow, 20 Aug 1995, *J.B. Phipps & R.J. O'Kennon 7170* (CAN, TRT, UWO). Between Vernon & Armstrong, intersection of Otter Lake Cross Road & Hales Rd., alt. ca. 1300 ft, in partial shade of Ponderosa Pine and Douglas fir forest, 2 m tall, fresh anthers pink, May 15, 1995, *L.S. & D. Donovan 2749* (UWO). Shuswap Valley, just E of Enderby, across bridge, W side of road, 250 m from gate, alt. ca. 1250 ft, level open field growing along roadside across from cattle feeder, bush 3.5 m tall, fresh anthers cream, 15 May 1995, *L.S. & D. Donovan 2741* (UWO). Kalamalka L. Provincial Park, bushy slopes above red gate, in seepage zone, 1550 ft, same sp. as *Wells 689-691*, bush 4 m tall, leaves coriaceous, shining, mid-green, fruit bright red with long calyx-lobes, 18 Aug 1994, *J.B. Phipps & R.J. O'Kennon 6982* (CAN, UBC, UWO, V). Just E of Enderby after bridge over Shuswap R., rough grass near water, S side of road, alt. 1250 ft, edge of water near oxbow of Shuswap R., bush 5 m tall, burgundy fruit, 25 Sep 1993, *J.B. Phipps & R.J. O'Kennon 6809* (UBC, UWO). E side of 97A, 1/2 mi N of intersection with 97, scrubby slopes with long cleared area, bush 4 m tall, fruit ± spherical, plum-colored, common here, 19 Aug 1994, *J.B. Phipps & R.J. O'Kennon 6997* (BRIT, TRT, UBC, UWO, V). Ca. 1 mi S of Enderby, gravel driveway to NE starting at Indian Cemetery, alt. 1300 ft, bush, 3.5 m tall, fruit bright red, ellipsoid, scarce here, 20 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7007* (UWO). Ca. 1 mi S of Enderby, gravel driveway to NE starting at Indian Cemetery, alt.

1300 ft, bush, 3.5 m tall, fruit ± orbicular, dull red, a few here, 20 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7005* (CAN, UBC, UWO, V). Mabel Lake Rd., 1.3 mi E of Enderby center, opposite house with solid wooden fence, alt. 1275 ft, bush, 5 m tall, fruit bright red, 20 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7020* (UWO). Kalamalka L. Provincial Park, brushy slopes above red gate, in seepage zone, alt. 1600 ft, bush, 4 m tall, leaves coriaceous, shining, mid green, fruit bright red with long calyx-lobes, 18 Aug 1994, *J.B. Phipps & R.J. O'Kennon 6983* (BRIT, UBC, UWO). Northern Okanagan, Spallumcheen Municipality, Marshall Rd., fruit scarlet, spherical, 20 Aug 1995, *J.B. Phipps 7171* (UWO).

U.S.A. WASHINGTON: Okanogan Co.: US 97, 1.1 km S of Ellisforde, hawthorn hedge over RR tracks in grazed field (mostly *C. macracantha*), alt. 275 m, bush, 4 m tall, dense, fruit deep red, + round, 23 Aug 1995, *J.B. Phipps 7176* (UWO, WS, WTU); Westside Rd. ca. 4 km N of Tonasket, huge hawthorn stand along riverside, 975 ft alt., bush, 7 m tall, fruit burgundy, spherical, 30 Sep 1993, *J.B. Phipps & R.J. O'Kennon 6868* (BRIT, UWO, WS, WTU); Palmer Lake, N side, alt. 1150 ft: thornless 7 m bush, fruit burgundy, 1 Oct 1993, *J.B. Phipps & R.J. O'Kennon 6873* (UWO, WS, WTU); Palmer Lake, N end, open hawthorn thicket along gravel beach, just E of Chopata Lodge, alt. 1150 ft, bush 7 m tall, thornless, burgundy fruit, 1 Oct 1993, *J.B. Phipps & R.J. O'Kennon 6875* (BRIT, UWO, WS, WTU); Palmer Lake, N side, anthers ivory, 4 May 1994, *J.B.Phipps 6095* (UWO, WS, WTU). **Spokane Co.:** Spokane, 03 Sep 1896, *C.V. Piper 2387* (WS). **Stevens Co.:** West End, Wellpinit, variety with maroon, barely hairy, softer berry, 12 Sep 1976, *R. May 258RM* (V).

3. Crataegus enderbyensis J.B. Phipps & O'Kennon, sp. nov. (**Fig. 8**). TYPE: CANADA: BRITISH COLUMBIA: just E of Enderby after bridge over Shuswap R., S side of road, rough grass near water; alt. ca. 1250 ft, large bush 5m tall, burgundy-red fruit, 25 Sep 1993, *J.B. Phipps & R.J. O'Kennon 6808* (HOLOTYPE: UWO; ISOTYPES: BRIT, CAN, DAO, UBC).

Frutices grandes vel arbores parvae, 5–6 m alti; ramuli unius anni purpureo-brunnei, veteriores atro-cinerei; spinae 2.5–3.5 cm longae, crassae, recurvatae, nitenter spadiceae in juventute. Folia decidua; petioli 1–2 cm longi, ± glabri; laminae 4–8 cm longae, ovato-rhombeae vel late ellipt-rhombeae in forma generali; forma plerumque convexae; basis late cuneata vel + rotudata; latera ca. 3-lobatae per latus, LFI max. ca. 20%; venatio craspedodroma (3–)4–5 venis per latus distincte impressis; margines leviter dentatae; textura coriacea, et color atrovirens in maturitate. facies adaxialis appresso-pubescens, abaxialis ± glabra, coloribus in autumno praeclaris. Inflorescentiae 15–25 florae; ramuli villosi, bracteolis caducis, linearibus, membranaceis, glandulo-marginatis. Flores 15 mm diam.; hypanthium extrinsecum glabrum; lobi calycis anguste-triangulares, tenuiter glandulo-marginati, abaxialiter glabri; petala circularia; stamina 10, antheris cremeis; carpelli et styli 3. Fructus 8–10 mm diam., ellipsoideo urceolati, saepe in corymbo magno pendente, cremei in juventute, tum armeniaci tum coccinei, in maturitate purpurei; reliquae calycis angustae, reflexae, pubescentes; pyrenae 3, dorsaliter sulcatae, lateribus planis vel vadositer foveatis.

Large bushes or small trees to 5 or 6 m tall; 1-year old twigs purple-brown, older dark gray; thorns 2.5–3.5 cm long, stout, recurved, shiny mahogany-brown when young. Leaves deciduous; petioles 1–2 cm long, ± glabrous; blades 4–8 cm long, ovate-rhombic to broad elliptic-rhombic in general shape; base broad-cuneate to ± rounded; with ca. 3 lobes per side, largest LFI ca. 20%; margins finely toothed; venation craspedodromous, distinctly impressed, with (3–)4–5 lateral veins per side; leathery and dark green at maturity, also rather convex; appressed-pubescent above, ± glabrous below except on the ± pubescent veins, brilliantly colored in fall. Inflorescences 12–25 flowered; branches villous, bearing caducous, linear, membranous, gland-margined, bracteoles. Flowers ca. 15 mm diam.;

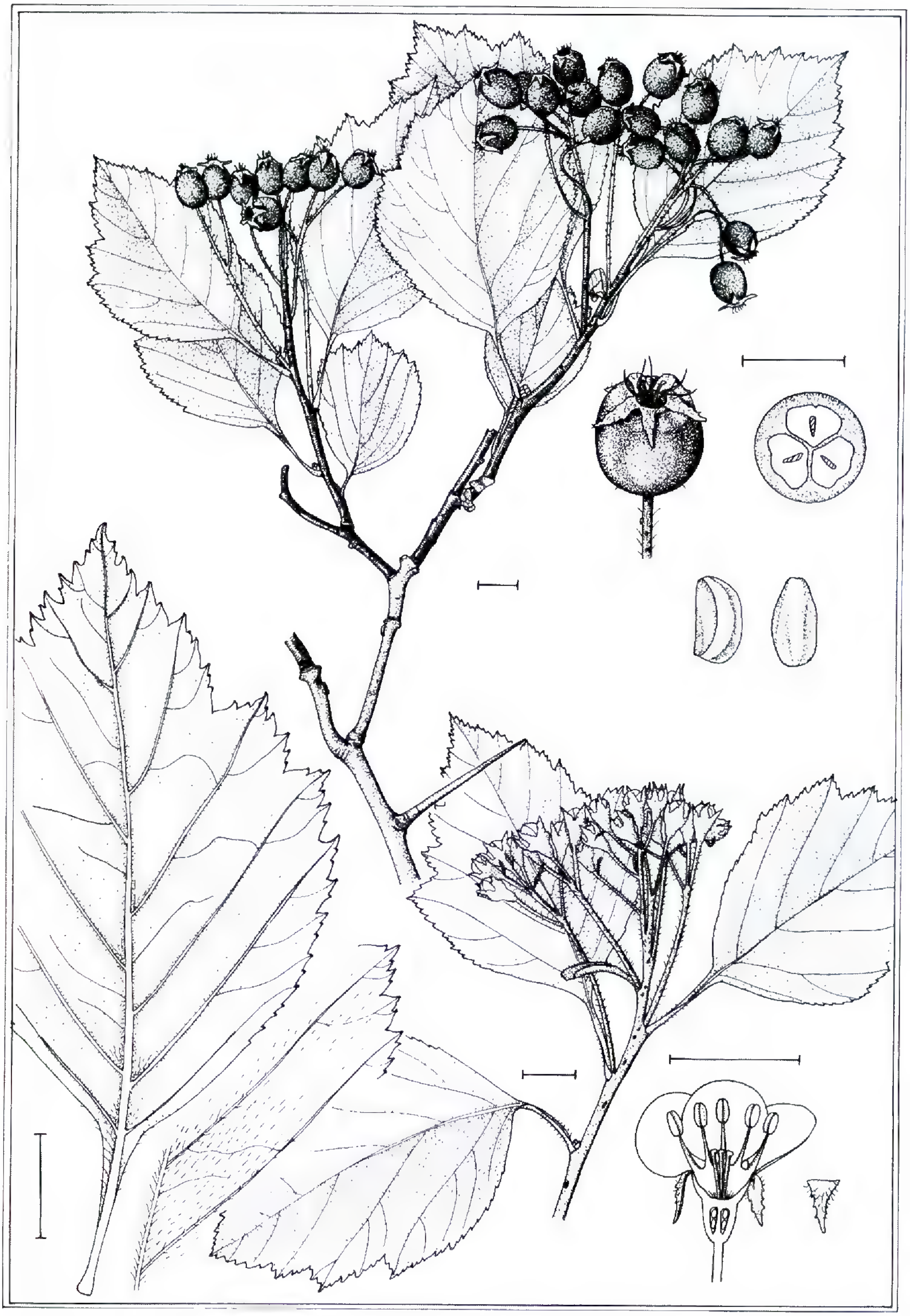


FIG. 8. Line drawing of *Crataegus enderbyensis*. Scale bars = 1 cm.

hypanthium glabrous externally; calyx-lobes narrow triangular, finely gland-margined, glabrous abaxially; petals ± circular; stamens 10, anthers cream; carpels and styles 3. Fruit 8–10 mm diam., ellipsoid-urceolate, often in a large, ± pendant corymb, cream when young, turning to apricot-colored then red, at full maturity purple; calyx-lobe remnants narrow, reflexed, pubescent; nutlets 3, dorsally furrowed, their sides plane or shallowly pitted.

Crataegus enderbyensis is presently only recorded from the Armstrong-Enderby region of the upper Okanagan of British Columbia where it is known from a good number of specimens. Collection localities may be identified, at least approximately, on figure 2.

This species is easily recognised in the field by its handsome, softly leathery, somewhat drooping, convex, dark green foliage, brilliantly colouring in fall, with clearly impressed venation, as well as by its usually large fruiting corymbs with their at first very pale, pendant fruit which become bright red by late August and finally turn purple-black. It is closely related to *C. okanaganensis*.

Additional specimens examined: **CANADA. BRITISH COLUMBIA:** Northern Okanagan, Spallumcheen Municipality, Powerhouse Rd., E side, near Stardel Drive, alt. ca. 1350 ft, hedges, bush, 3.5 m tall, fruit ellipsoid, orange-red, 19 Aug 1995, *J.B. Phipps 7163* (UWO). Between Vernon & Armstrong, intersection of Otter Lake Cross Road and Hales Road, alt. ca. 1300 ft, in partial shade of Ponderosa Pine and Douglas Fir forest, bush 2 m tall, anthers cream, fls. not quite out, 15 May 1995, *L.S. & D. Donovan 2750* (UWO). Between Vernon & Armstrong, intersection of Otter Lake Cross Road & Hales Road, alt. ca. 1300 ft, in partial shade of Ponderosa Pine and Douglas Fir forest, 5 m tall, fresh anthers cream colored, 15 May 1995, *L.S. & D. Donovan 2747* (UWO). Between Vernon & Armstrong, intersection of Otter Lake Cross Rd & Hales Rd., ditch & road edge backing mesic forest, NW side of road near little valley, alt. 1300 ft, forest margins, mesic, bush 3.5 m tall, fruit cream turning salmon, 21 Aug 1994, *J.B. Phipps, & R.J. O'Kennon 7032* (UWO). Ca. 200 m E of bridge over Shuswap Rd. on road Enderby to Mabel Lake, S side of road, alt. 1250 ft, (equals *J.B. Phipps & R.J. O'Kennon 6808*), bush 5 m tall, nearest road, frt. elliptical, pendant, shades of red (pale to deep), 20 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7010* (BRIT, UBC, UWO). Back Enderby Rd., ca. 4 mi SE of Enderby, ca. 200 m N of creek crossing, alt. ca. 1450 ft, dense hedges E side of road, bush, 5 m tall, fruit pale, 21 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7040* (UWO). Ca. 5 km ENE of Armstrong on E-W aligned rd. just ENE of Armstrong airport, hedgerows, S side of road, alt. 1450 ft, bush 5 m tall, 21 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7042* (UWO). Mabel L. Rd, 1.25 mi E of Enderby ca. 200 m E of "Autobody collision, repairs & painting sign," alt. 1275 ft, hedgerow, bush, 5.5 m tall, leaves with deeply impressed veins, very coriaceous, fruit unripe, cream-salmon, 20 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7018* (BRIT, UWO). Shuswap Valley, just E of Enderby, across bridge, S side of rd. on mound by roadside depression, alt. ca. 1250 ft, bush 5 m tall, 10 stamens, ivory anthers, in bud, 05 May 1994, *J.B. Phipps 6911* (UBC,UWO)[also JBP 6914,6915,6916 (UWO)]. Ca. 1.7 mi E of Enderby on Kingfisher Rd, on S side at beginning of S-bend, S of prominent hill, fence line of road backed by woodland, alt. 1280 ft, bush 3 m tall, foliage colors autumnal, fruit purple, 25 Sep 1993, *J.B. Phipps & R.J.O'Kennon 6813* (UWO). Ca. 1.7 mi E of Enderby on Kingfisher Rd on S side at beginning of S-bend, S of prominent hill, fence line of road backed by woodland, alt. 1280 ft, bush 4 m tall, fruit purple, foliage deep green, 25 Sep 1993, *J.B. Phipps & R.J. O'Kennon 6812* (UBC, UWO).

4. Crataegus orbicularis J.B. Phipps & O'Kennon, sp. nov. (**Fig. 9**). TYPE: CANADA: BRITISH COLUMBIA, Northern Okanagan, Spallumcheen Municipality, Back Enderby Rd., ca. 4 mi SE of Enderby, ca. 200 m N of creek crossing, alt. ca. 1450 ft, dense

hedges E side of road, bush 4 m tall, large, orbiculate leaves, fruit pale deep red, 21 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7039* (HOLOTYPE: UWO; ISOTYPES: BRIT, CAN, MO, TRT, UBC).

Frutices, late-patentes, 2–4 m alti; ramuli unius anni in autumno brunnei; rami fusco-brunnei; spinae 3–5 cm longae, graciles, rectae vel plerumque leviter recurvatae. Folia decidua; petioli 1.25–2.0 cm longi, adaxialiter breviter pilosi plerumque eglandulati; laminae plerumque 5–8 cm longae, ellipticae vel fere circulares, latioribus curvatis per basem, angustioribus ± attenuatis; venatio craspedodroma, venis secondariis 5–6(–7) per latus; lobi 3–4 per latus, breves, triangulares IFI ≤ 10%; margines cum dentibus brevissimis praeter basim; facies adaxialis breviter appresso-pilosa, abaxialis sparse pilosa, magis pubescentibus in venis. Inflorescentia 10–18 florae, ramulis subglabris distaliter, sparsim villosis proxime, bracteolis caducis, linearibus, membranaceis, glandulo-marginatis. Flores ca. 18 mm diam.; hypanthium extrinsecum sub-glabrum; lobi calycis 2–3 mm longi, anguste-triangulares, tenuiter glandulo-marginati; stamina 10, antheris roseis; carpelli et styli 3–4. Fructus 8 mm diam., oblongi, glabri, coccinei vel purpurei, in infructescentiis insignibus; lobi calycis conspicui, ± erecto-patentes; pyrenae 3–4, dorsaliter sulcatae, lateribus ± planis vel vadositer foveolatis.

Wide-spreading bushes, 2–4 m tall; 1 year old twigs strong mid-brown, branches dull gray; thorns 3–5 cm long, slimmish, straight or more usually slightly recurved; Leaves deciduous, petiolate; petioles 1.25–2.0 cm long, adaxially shortly hairy, usually eglandular; blades mainly 5–8 cm long, broadly elliptic to nearly orbicular, the broader ones curved across the base, the narrower somewhat attenuated; venation craspedodromous, with 5–6(–7) secondary veins per side; with 3–4 short triangular lobes, LII ≤ 10 %; margins with very small teeth except near the base; shortly appressed hairy above, thin-hairy below, more pubescent on veins. Inflorescences 10–18 flowered; branches sub-glabrous distally, sparsely villous proximally, bearing caducous, linear, membranous, gland-margined bracteoles. Flowers ca. 18 mm diam.; hypanthium sub-glabrous externally; calyx-lobes 2–3 mm long, narrow-triangular, finely gland-margined; stamens 10, anthers pink; carpels and styles 3–4. Fruit 8 mm diam., oblong, glabrous, red, later changing to plum when fully ripe, in showy infructescences; calyx-lobes very conspicuous, erecto-patent; nutlets 3–4, dorsally sulcate, their sides ± plane or shallowly and smoothly pitted.

This is a very attractive species so far only known within a few miles of Enderby, B.C. and easily recognized by the foliage shape, thorn-type and fruit (color, conspicuous calyx-lobes). *Crataegus orbicularis* stands out in early spring with its light green, tinted eau-de-nil, foliage and handsome clusters of large flowers. Collection localities may be identified, at least approximately, on figure 2.

Additional specimens examined: **CANADA. BRITISH COLUMBIA:** Northern Okanagan, Spallumcheen Municipality, Back Enderby Road, hedges, E side, alt. ca. 1450 ft, same as *J.B. Phipps & R.J. O'Kennon 7039* but leaves smaller this year, bush 3.5 m tall, fruit lake, 19 Aug 1995, *J.B. Phipps 7166* (BRIT, MONTU, UBC, UWO). Northern Okanagan, Spallumcheen Municipality, Mountain View Road, N end, E side, alt. ca. 1500 ft, 19 Aug 1995, *J.B. Phipps 7165* (BRIT, UBC, UWO, V). Ca. 10 km N of Armstrong, W of Indian Reservation, alt. ca. 1550 ft, long farm drive with *Crataegus* hedgerow, bush, 2 m tall, fruit in various shades of red, 21 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7036* (BRIT, UBC, UWO, V). Mabel Lake Rd., 1.3 mi E of Enderby center, opposite house with solid wooden fence, alt. 1275 ft, bush, 3 m



Fig. 9. Line drawing of *Crataegus orbicularis*. Scale bars = 1 cm.

tall, foliage large, fruit pale-medium red, 20 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7019* (BRIT, MONTU, UBC, UWO, V). Shuswap Valley, ca. 2.8 km E of Enderby on Kingfisher Rd., in hedgerow on S side road opp. house with wooden fence on N side, alt. ca. 1280 ft, bush 3 m tall, large flowers, 10 stamens, pink anthers, (possibly =*J.B. Phipps & R.J. O'Kennon 6813*), 05 May 1994, *J.B. Phipps 6920* (UWO). Northern Okanagan, Spallumcheen Municipality, Back Enderby Rd., 21 Sep 1998, *W.J.T. Phipps a & c* (UWO).

5. Crataegus atrovirens J.B.Phipps & O'Kennon, sp. nov. (**Fig. 10**). TYPE: CANADA: BRITISH COLUMBIA: Northern Okanagan, Spallumcheen Municipality, Otter Lake Cross Road, 22 Aug 2000, *J.B. Phipps 8171 & S.R. Phipps* (HOLOTYPE: UWO; ISOTYPES: BRIT, CAN, MO, TRT, UBC, US).

Frutices 2–5 m alti, caulis multiplicibus suberectis vel erectis. Ramuli elongati pubescentes, illi unius annus brunnei nitentes, veteriores atrocinerei; spinae 3–5 cm longae, numerosi, ± rectae vel leviter curvatae, nitentes atrobrunneae, ad apices nigrae, veteriores atrocinereae. Folia decidua; petioli longitudine 15–20% illius laminarum, dense pubescentes in sulco adaxiali, in maturitate sparse pubescentes, eglandulosi vel cum paucis, parvis glandibus praecipue distalibus; laminae 4–6(–7) cm longae, anguste-ovatae ad late elliptico-rhombeas vel late ellipticas in forma generali; apex acutus vel subacutus, basis cuneata; latera cum 3–4 lobis parvis subacutis vel obtusis, IFI sinus maximi ca. 10%; margines tenuiter serrati, dentibus acutis vel subacutis, ferentes glandes minusculas ad apices; venatio craspedodroma, venis 3–5 per latus; indumentum appresso-scabrum adaxialiter, abradens in maturitate, abaxialiter fere glabrum; in maturitate color atrovirens et ± coriacea, colore in autumno glandulacea. Inflorescentiae 8–15 floratae; rami ± dense patente-pubescentes. Flores 10–13 mm diam.; hypanthium extrinsecus pubescens; lobi calycis anguste-triangulares, marginibus glandulo-serratis ad glandulo-laciniatis; petala alba; stamina 10, antheris roseis; styli 2–3. Fructus 13–15 mm alti, 10 mm lati, ± ellipsoidei, vinacei in mense Augusto exeunte, atropurpurei in mense Septembro, ± villosi; caro dulcis, aurantiaca; lobi calycis valde prominentes, suberecti; pyrenae 2–3, dorsaliter sulcata, in lateribus foveolatis.

Shrubs, 2–5 m tall, with multiple, mainly suberect to erect stems. Extending branches of the season pubescent; at 1 yr glossy brown; older dark gray; thorns 3–5 cm long, numerous ± straight to very slightly curved, at 2 yr. glossy dark brown, black at the tip, older deep gray. Leaves deciduous; petioles 15–20 % length of blades, densely pubescent at maturity in the adaxial groove, sparsely pubescent elsewhere, eglandular to with a few small glands mainly distally; blades 4–6(–7) cm long, narrow-ovate to broadly ellipt-rhombic or broad-elliptic in general shape; tip acute to subacute, base cuneate; sides with 3–4 small subacute to obtuse lobes, LII of largest sinus ca. 10%; margins finely toothed, teeth acute to subacute, bearing minute glands at their tips; venation craspedodromous, 3–5 veins per side; adaxially with scabrous appressed pubescence, abrading with age, abaxially nearly glabrous; dark green and somewhat coriaceous at maturity, in fall turning bronze-brown. Inflorescences 8–15 flowered; branches with a fairly dense spreading pubescence. Flowers 10–13 mm diam.; hypanthium externally pubescent; calyx lobes narrow-triangular, margins glandular-serrate to glandular-laciniate; petals white; stamens 10, anthers pink; styles 2–3. Fruit 13–15 mm high, 10 mm wide, ± ellipsoid, burgundy in late August, blackish-purple a month later; variably hairy; flesh soft orange color; calyx-lobes very prominent, suberect; nutlets 2–3, dorsally grooved, pitted on the sides.



FIG. 10. Line drawing of *Crataegus atrovirens*. Flowers were not available when the drawing was prepared. Scale bars = 1 cm.

Crataegus atrovirens is now known from about 20 collections and many more specimens on the ground from an area of about 10 miles north and south of Enderby, British Columbia, where it is locally common to abundant in natural hedgerows and other brushy sites in the valley. Collection localities may be identified, at least approximately, on figure 2. This taxon appears quite distinct from other sympatric kinds and is often recognizable in habit alone.

Of species known to date from the northern Okanagan, *C. shuswapensis*, also newly described in this paper, is the one most likely to be confused with *C.*

atrovirens. The coloring of *C. shuswapensis* is similar, but it has a finer, more wide-branching growth habit, and a glabrous inflorescence, redder fruit in the fourth week of August, much smaller and more recurved calyx-lobes in fruit, whose margins rather than being serrato-laciniate, are merely minutely glandular. In addition, the leaves of *C. shuswapensis* are more sharply lobed. *Crataegus atrovirens* is probably more closely related to *C. okanaganensis*, but is easily differentiated from that species in the field by the much darker coloring of foliage, fruit and bark, as well as by its pink anthers. Compared to *C. orbicularis* the fruit is conspicuously larger and more hairy in *C. atrovirens* and is soft and ripe in the fourth week of August when it is hard and unripe in *C. orbicularis*. It is a dull hawthorn, sombre in appearance, contrasting markedly with more flashy congeners such as *C. okanaganensis*. It appears to be more xeromorphic than other fairly large Okanagan hawthorns.

Additional specimens examined: **CANADA. BRITISH COLUMBIA:** Okanagan Valley, NNE of Vernon, Pleasant Valley Rd., hedge behind Vowle's residence, alt. 380 m, natural hedge, bush 3 m tall, 19 Aug 1994, *J.B. Phipps 6996 & R.J. O'Kennon* (UWO). Northern Okanagan, Spallumcheen Municipality, Stepney Cross-Road, bush 5 m tall, 26 Aug 2000, *J.B. Phipps 8184 & S.R. Phipps* (UWO). Northern Okanagan, Spallumcheen Municipality, Back Enderby Rd., ca. 1 mi N of S end, bush 5 m tall, 26 Aug 2000, *J.B. Phipps 8181 & S.R. Phipps* (UWO, V). Northern Okanagan, Spallumcheen Municipality, Back Enderby Rd., 1/4 mi from S end, bush, 2.5 m tall, 26 Aug 2000, *J.B. Phipps 8179 & S.R. Phipps* (UBC, UWO). Northern Okanagan, Spallumcheen Municipality, Back Enderby Rd., near S end, bush, 3 m tall, *J.B. Phipps 8180 & S.R. Phipps* (CAN, UWO). Northern Okanagan, Spallumcheen Municipality, Marshall Rd., bush, 4 m tall, *J.B. Phipps 8186 & S.R. Phipps* (UWO). Northern Okanagan, Hwy. 6 E of Vernon, ca. 2 mi W of Lumby, bush, 12 ft tall, 26 Aug 2000, *J.B. Phipps 8188 & S.R. Phipps* (UWO). Shuswap Valley, ca. 3 mi NNE of Enderby, Anderson Rd., bush, 3 m tall, 26 Aug 2000, *J.B. Phipps 8185 & S.R. Phipps* (BRIT, UWO). Enderby, 6 Aug 1898, *J.R. Anderson s.n.* (UWO, V). Hwy 97, ca. 2.5 km S of Enderby (S of Indian Cemetery), roadside, E side, backing alfalfa field, alt. 1320 ft, dense shrub, 3 m tall, coriaceous leaves, deep green, fruit purple, abundant here, 20 Aug 1994, *J.B. Phipps & R.J. O'Kennon 7008* (UWO).

6. Crataegus phippsii O'Kennon, Sida 18:185. 1998.

ACKNOWLEDGMENTS

The line drawings were prepared by Susan Laurie-Bourque of Hull, Quebec who is thanked by the authors for the beauty of her realisations and her meticulous attention to detail. Susan Laurie-Bourque also artistically improved the rather crude output of Range-Mapper by using Corel Draw. The work was largely funded by grants to the first author by the National Sciences and Engineering Research Council of Canada. We also wish to thank Laurie Donovan of Okanagan University College, Vernon, British Columbia, for collection of critical flowering material at times when we were unable to be present and Antony Littlewood, Dept. of Classical Studies, The University of Western Ontario, for critically checking the Latin diagnoses.

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NEW COMBINATION IN *XYLORHIZA* (ASTERACEAE: ASTEREAE)

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ABSTRACT

Xylorhiza glabriuscula var. *linearifolia* is treated within *Xylorhiza* at specific rank as ***Xylorhiza linearifolia*** (T.J. Wats.) Nesom, comb. nov. *Xylorhiza linearifolia* is geographically isolated from *X. glabriuscula* sensu stricto, but it does overlap and apparently hybridize with *X. tortifolia* var. *imberbis*.

ABSTRACT

Xylorhiza glabriuscula var. *linearifolia* se trata dentro *Xylorhiza* a nivel específico como ***Xylorhiza linearifolia*** (T.J. Wats.) Nesom, comb. nov. *Xylorhiza linearifolia* está aislada geográficamente de *X. glabriuscula* sensu stricto, pero se solapa y aparentemente se hibrida con *X. tortifolia* var. *imberbis*.

Watson (1977) described *Xylorhiza glabriuscula* Nutt. var. *linearifolia* T.J. Wats. from the region of Moab in east-central Utah. Cronquist (1994) observed that it "appears to form a distinctive local taxon with a range more than 60 km long" and treated it at specific rank, but he placed it within a broadly defined *Machaeranthera*. Welsh et al. (1993) followed Watson's treatment. For the treatment of Asteraceae in the developing Flora of North America, this taxon is recognized at specific rank and the following combination is required to place it within *Xylorhiza*.

Xylorhiza linearifolia (T.J. Wats.) Nesom, comb. nov. BASIONYM: *Xylorhiza glabriuscula* Nutt. var. *linearifolia* T.J. Wats., Brittonia 29:215. 1977. *Machaeranthera linearifolia* (T.J. Wats.) Cronq., Intermountain Fl. 5:274. 1994. TYPE: UNITED STATES. UTAH. Grand Co.: 6 mi NW of Moab on US Hwy 160, 21 May 1971, *T.J. Watson 679* (HOLOTYPE: TEX!; ISOTYPES: COLO, GH, MO!, MONTU, NY, UC).

Xylorhiza glabriuscula, *X. linearifolia*, and *X. venusta* (M.E. Jones) Heller are closely morphologically similar among themselves and presumably are closely interrelated. All three have diploid populations; *X. venusta* and *X. linearifolia* also have tetraploid populations (Watson 1978). Within *X. linearifolia*, the two cytotypes "grow intermixed over the small range of the taxon" (Watson 1978); four populations of diploids and four of tetraploids were found, all within Grand County, Utah. According to Stockton (1983), the diploids and tetraploids of *X. linearifolia* differ in minor ways, but the present study (following Watson) finds no variation that would require further nomenclatural differentiation.

Watson (1977, p. 215) observed that *Xylorhiza linearifolia* (as var. *linearifolia*) "overlaps morphologically" with *X. glabriuscula* (var. *glabriuscula*) but the

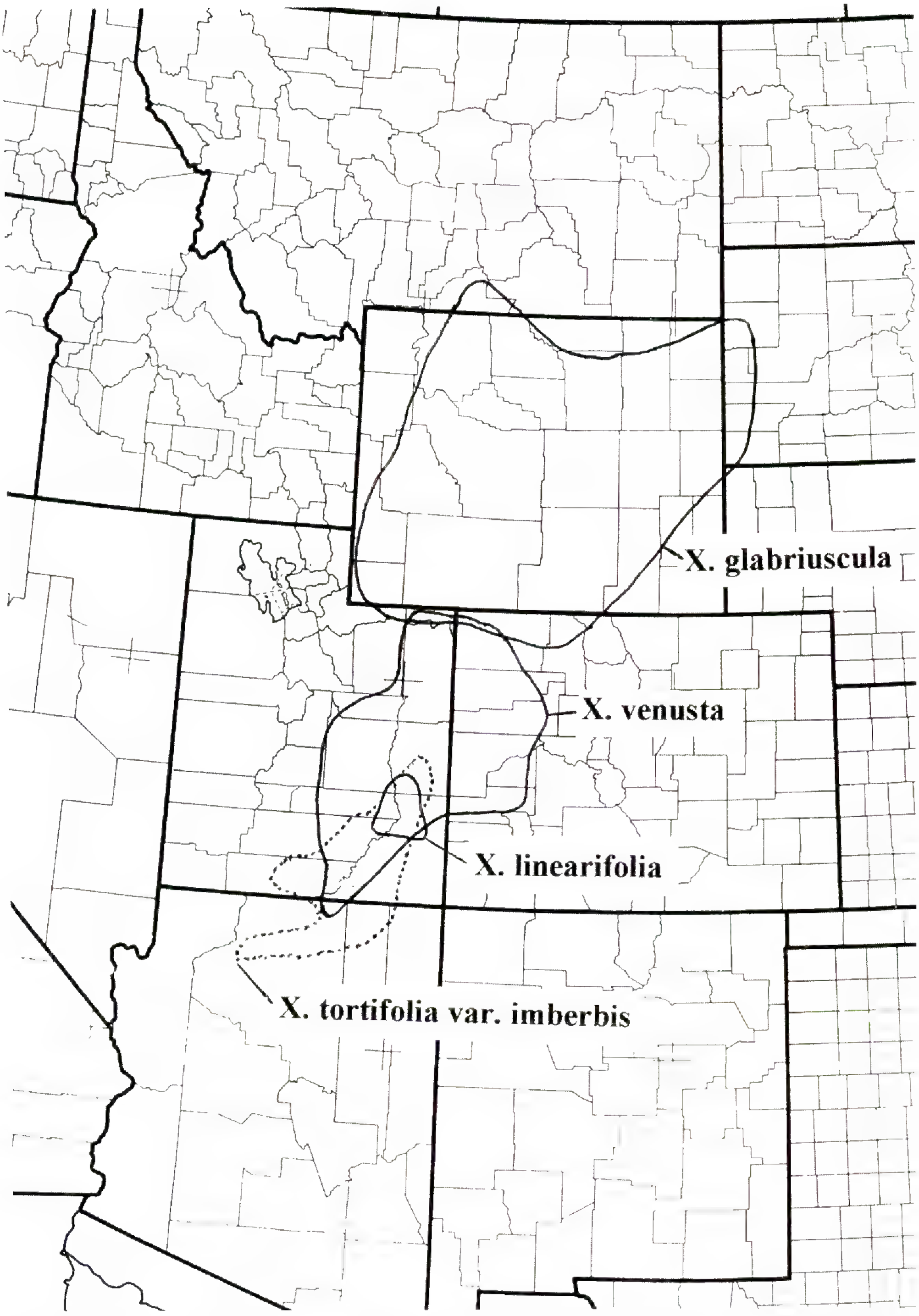


FIG. 1. Geographic distribution of *Xylorhiza linearifolia*, *X. glabriuscula*, *X. venusta*, and *X. tortifolia* var. *imberbis*. Outlines of the species ranges were derived from data from collections at BRIT-SMU, TEX-LL, MO, and published sources, primarily Watson (1977) and Albee et al. (1988). The Arizona record for *X. venusta* was not reported by Watson (1977): Coconino Co., Lee's Ferry, 6 Jun 1927, *Cottam C2611* (LL!).

present study notes that *X. linearifolia* similarly overlaps with *X. venusta*. *Xylorhiza linearifolia* differs from both taxa in its leaf morphology, as outlined by the following key.

1. Leaves linear-oblong, truncate or rounded-auriculate at the base _____ **Xylorhiza linearifolia**
1. Leaves oblanceolate to oblong-spatulate, tapering at the base.
   2. Stems leafy for more than 2/3 of their length, peduncles 2–6 cm long; leaves 2.5–8 mm wide; involucres 7–14 mm long, 12–25 mm wide _____ **Xylorhiza glabriuscula**
   2. Stems leafy in the lower 1/2–2/3 of their length, peduncles 6–20 cm; leaves 2.5 15 mm wide; involucres 12–20 mm long, 20 35 mm wide _____ **Xylorhiza venusta**

Xylorhiza glabriuscula and *X. venusta* have slightly overlapping ranges in northeastern Utah and northwestern Colorado (Fig. 1) and intermediates, presumably of hybrid origin, occur in that region (Watson 1977). The range of *X. linearifolia* is essentially imbedded within that of *X. venusta*, but no evidence of hybridization between these two taxa has been reported. *Xylorhiza linearifolia* apparently is reproductively isolated from both of its close relatives.

In contrast to the isolation of *Xylorhiza linearifolia* from *X. glabriuscula* and *X. venusta*, the range of *X. tortifolia* var. *imberbis* (Cronq.) T.J. Wats. contacts that of *X. linearifolia* from the south and these two taxa grow intermixed within a few localities. "In these zones of contact, intermediates (suggesting hybridization) are found" (Watson 1977, p. 215).

Stockton (1983) noted that *Xylorhiza linearifolia* is intermediate in morphology and habitat between *X. glabriuscula* sensu stricto and *X. tortifolia* var. *imberbis* and suggested that *X. linearifolia* may be "a stabilized hybrid derivative" between them, presumably from an earlier time when the putatively parental species were sympatric. Further evidence that would test this hypothesis is lacking.

ACKNOWLEDGMENTS

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BOOK REVIEW

B.G. Bowes. 2000. **A Color Atlas of Plant Structure.** (ISBN 0-8138-2693-4, pbk.). Iowa State Press, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax; www.iowastatepress.com). $49.95, 192 pp, numerous color plates, 7 3/4" × 10 1/4".

The amount of information generated in the many fields of plant science is growing at an exponential rate. The detailed study of plant anatomy should be a vital component in the training for any student of plant biology. However, with the advent of new analytical techniques in molecular biology, biochemistry, and physiology, many students cannot find the time in their program of study to include a course in basic plant anatomy. In fact, in some botany programs it is even difficult to find a faculty member who has sufficient training in this field to provide students with a solid background.

This book provides a long-awaited solution to both of these problems. One of the most difficult tasks for instructors teaching beginning botany students is to teach them how to understand plant anatomy using microscopic cross-sections of the various organs. Part of that difficulty lies either with the student's inexperience in using microscopes, or in the poor quality of microscopes used in teaching many undergraduate laboratories.

Bryan Bowes' *Color Atlas of Plant Structure* is a beautifully illustrated and concise introduction to the fascinating world of plant anatomy. Each chapter consists of several pages of text, with abundant references to illustrations on the following pages. The text is concise and to the point, leaving much of the detailed description to be presented with the illustrations themselves. Those illustrations are captioned with a wealth of information. Structures referred to in the captions are numbered, not lettered or labeled, which makes each photograph easier to understand.

The organization of the book follows that presented in many basic botany courses. The first chapter provides an overview of the major Divisions of vascular and non-vascular plants, and concludes with a brief introduction to the gross morphology of flowering plants. Chapters 2–4 provide a discussion of plant cells, tissues and embryology. Chapters 5–8 deal with leaf, stem, root, and floral anatomy.

The illustrations themselves are beautifully done, and each is labeled to indicate the type of microscopy used to create the photograph. There are two or three photographs on each page, and the captions are arranged in such a way that it is easy to determine which caption refers to which photo. The only difficulty this reviewer had with the illustrations was that occasionally the numbers referring to salient points, were difficult to see on the photographs.

This book is a wonderful reference for anyone involved in the plant sciences. It should be a required text or at least an available reference in all basic botany and taxonomy classes, and deserves a place in the personal libraries of botanists, horticulturalists, naturalists and natural history artists alike.—*Debra Trock, Collections Manager, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A.*

LECTOTYPIFICATION OF *PSEUDOGNAPHALIUM BIOLETTII* (GNAPHALIEAE: ASTERACEAE)

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Pseudognaphalium biolettii A. Anderb. [nom. nov.], Opera Bot. 104:147. 1991. *Gnaphalium bicolor* Bioletti, Erythea 1:16. 1893 [non *Gnaphalium* (*Helichrysum*) *bicolor* (Lindl.) Schultz-Bip., Bot. Zeit. 3:171. 1845; nec *Gnaphalium bicolor* Franch., J. Bot. (Morot) 10:411. 1896]. TYPE: U.S.A. **California**. Without designating a type, Bioletti (1893, p. 17) noted that "The description is drawn up from dried specimens from San Diego and from a plant growing in the Garden of Native Plants at the University of California. ... Common in low thickets among the coast hills about San Diego, according to Prof. Greene. ..." At UC, there are at least two specimens of *Gnaphalium bicolor* that might represent the material referred to by Bioletti: San Diego, 25 Mar 1891, *G.W. Dunn s.n.* (UC 31964); San Diego Co, Witch Creek, 1893, *R.D. Alderson s.n.* (UC 31965). Two ND-G specimens, however, apparently more clearly represent authentic type material—they are labeled "*Gnaphalium bicolor*, Bioletti, Erythea 1.16. Berkeley, Bot. Garden, 1892," without other information (lectotype, designated here: ND-G 59203, photocopy!; isolectotype: ND-G 59205, photocopy!). These two large branches were broken above the base, without roots, and their similarity suggests they may have been collected from a single plant. The morphology of the ND-G types indicates that this species consistently has been identified correctly.

Perennial herbs, taprooted, fragrant, the stems 2–7(–12) dm tall, much-branched at the base and commonly lignescent, eglandular, persistently tomentose above, glabrescent or not below. Leaves oblanceolate to oblong-oblanceolate, mostly 1.5–5(–8) cm long, 4–10(–15) mm wide, the upper becoming lanceolate, widely to narrowly auriculate-clasping, not decurrent, strongly bicolored, bright green and usually densely glandular above, persistently white-tomentose beneath, sometimes the upper leaves glandular but those toward the base eglandular. Capitula 5–5.5(–6) mm high; phyllaries shiny opaque-white, sometimes slightly pinkish, strongly graduated, apex rounded to nearly truncate, apiculate. Pistillate flowers 41–73. Bisexual flowers 5–13. Cypselae shallowly ridged, not papillate.

Pseudognaphalium biolettii occurs in the southern/southwestern half of California and in adjacent Mexico (Baja California and Baja California Sur), at elevations of 5–1200 meters (under 600 meters in California) on rocky slopes, sandy plains with *Larrea*, coastal strand, matorral, and chaparral.

ACKNOWLEDGMENTS

Barbara Hellenthal provided information and photocopies of the relevant ND-G

specimens of *Gnaphalium bicolor* and John Strother provided information regarding material of *G. bicolor* at UC and JEPS. Review comments of K. Gandhi and J. McNeill also are much appreciated.

REFERENCE

Bioletti, F.T. 1893. Two new Californian plants. Erythea 1:16–17.

BOERHAVIA COULTERI VAR. *PALMERI*, A NEW VARIETAL COMBINATION FOR *BOERHAVIA* (NYCTAGINACEAE) OF SOUTHWESTERN NORTH AMERICA

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ABSTRACT

Boerhavia coulteri (Hook. f.) S. Wats. var. *palmeri* (S. Wats.) Spellenb., comb. nov., based on *B. spicata* Choisy var. *palmeri* S. Wats., from the vicinity of Guaymas, Sonora, Mexico, is proposed for a *Boerhavia* that differs from the var. *coulteri* in its small fruits and flowers, and its with sparsely-fruited spicate inflorescences. The variety ranges from the Channel Islands of California to the Big Bend region of Texas near the Río Grande, and is very common on the Sonoran Desert. The two varieties are often sympatric, and they intergrade to a slight extent. A key is presented to distinguish the species of *Boerhavia* with spicate inflorescences in the United States.

RESUMEN

Boerhavia coulteri (Hook. f.) S. Wats. var *palmeri* (S. Wats.) Spellenb., comb. nov., basada en *B. spicata* Choisy var. *palmeri* S. Wats., de la vecindad de Guaymas, Sonora, México, se propuso para una forma de *Boerhavia* que difiere de la variedad *coulteri* por su frutos y flores pequeños, y su frutos esparcidos en inflorescencias espiciformes. La variedad se extiende desde las Islas Canales de California hasta la región del "Big Bend" del Río Bravo del Norte de Texas, y es muy común en el Desierto Sonorense. Las variedades a menudo son simpátricas, y se intergradan un poco. Se presenta una clave para distinguir las especies con inflorescencias espigadas de *Boerhavia* de los Estados Unidos de América.

The species of *Boerhavia* with spicate inflorescences have proven taxonomically difficult for the past century, the variation presented by the complex resulting in very different taxonomic treatments. At one extreme is that of Standley (1911) where nine species were recognized. In 1918 Standley submerged *B. watsoni* as a synonym of *B. coulteri*, but maintained the other taxa he had recognized. At the other extreme is Reed's (1969) treatment, in which five of the species Standley recognized [*B. coulteri* (Hook. f.) S. Wats., *B. rosei* Standl., *B. spicata* Choisy in D.C., *B. torreyana* (S. Wats.) Standl., *B. watsoni* Standl.] were placed as synonyms in one variable species, *B. spicata*. Most authors of floras that include all or part of the Sonoran Desert region have followed Standley (1918) in recognizing *B. coulteri*, and also *B. spicata*, and *B. torreyana* if they were present in the area of concern (Spellenberg 1993; Martin & Hutchins 1980; Kearney & Peebles 1964; Munz & Keck 1968; Wiggins 1964). In contrast, Felger (2000) recognized some plants included in *B. coulteri*, as broadly constructed by those authors, as *B. spicata* var. *palmeri* S. Wats. It is this taxon that is recognized as a variety of *B. coulteri* in this paper.

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While studying the complex for an upcoming treatment for the Flora of North America North of Mexico, I noted that *B. torreyana* was conspicuously papillate in the sulci between the ribs of the fruit, a character previously unpublished. None of the other *Boerhavia* taxa in the complex are at all papillate. Watson (1889) cited no specimens when he coined the name *Boerhavia spicata* var. *torreyana* S. Wats., but specimens from western Texas collected during the mid-19th century Boundary Survey, very likely seen by him, have papillate fruits (specimens from Torrey Herbarium, NY, have been seen; relevant specimens from GH on loan to ENCB have not been seen). The character of papillae on the fruit is consistent in populations from western Texas, New Mexico, southeastern Arizona at higher elevations, throughout much of Arizona north of the Mogollon Rim, and extreme south-central Utah (= *B. spicata* by Welsh et al. 1987). On very similar appearing plants from the Sonoran Desert region, some of which are identified as *B. torreyana* in collections, but which actually represent *B. coulteri* var. *palmeri* (as proposed below), papillae are absent and sulci are much narrower and less rugose. That *B. torreyana* is clearly distinguishable from other spicate *Boerhavia* has helped to clarify the complex. This is particularly so in Arizona and Sonora where three or four very similar taxa occur within the region.

In 1889 Watson transferred *Senkenbergia coulteri* Hook. f. to *Boerhavia*, and he stated that the collection upon which the name was based was *Coulter 1425*. He noted that the perianth was one line in length (= 1/12", ca. 2 mm) and that fruits were clavate, 1–1.5 lines long, truncate, and acutely angled. Only one such specimen exists in the Hooker Herbarium at Kew. It is labeled as having come from "Alta Sonora, Mexico," and is here considered the holotype (photo and photocopies at NMC). Its fruits are clearly in irregularly fasciculate clusters in the spicate inflorescence, and they are truncate at the apex. On the same page of his 1889 publication, Watson stated that his new variety, *Boerhavia spicata* var. *palmeri*, based on the collection *Palmer 141* from Guaymas, Sonora, in 1887, had perianths 0.5 line long, and fruits clavate-oblong, a line long, obtuse, obtusely angled. He also noted the inflorescence to be "open and very slender." *Palmer 141* is represented by two specimens at GH! (on loan to ENCB, lectotype not selected; fragment at DS!). In raising this taxon to specific status, Standley (1909) had to adopt a new name (*B. watsoni*) because the binomial *B. palmeri* S. Wats. was occupied. He noted that Arizona plants were placed there somewhat doubtfully, suggesting that geography would place them with *B. coulteri*. Relative to other plants in the complex, the plants he identified as *B. watsoni* have smaller, more widely spaced, less clustered fruits (if at all clustered), and seem to have had stems that were decumbent-spreading.

It is proposed here that the populations Standley recognized as *B. watsoni*, and that Watson described as *B. spicata* var. *palmeri*, are part of the *B. coulteri* complex and can be recognized at the varietal level. The following combination is proposed:

Boerhavia coulteri (Hook. f.) S. Wats. var. **palmeri** (S. Wats.) Spellenb., comb. nov.
Boerhavia spicata Choisy var. *palmeri* S. Wats., Proc. Amer. Acad. 24:70. 1889.

The differences the two varieties of *B. coulteri* that Watson, and later Standley, noted by their classifications are very apparent in the field in their extreme states, but intergradient plants occur. Occasionally *B. coulteri* var. *coulteri* and var. *palmeri* are intermixed in populations (e.g., *Spellenberg & Zucker 12954* = var. *palmeri*, *12955* = var. *coulteri*, AZ, Pima Co., ca. 10 air km SW of Marana, Anway Rd. 1 km S of Avra Valley Rd., 16 Aug. 1999; NMC). In the two mixed populations I have seen, the taxa differed in habit, the stems of var. *coulteri* decumbent at the immediate base, then strongly ascending or erect, contrasting to the more decumbent-spreading habit of var. *palmeri*, but habit is very likely to be influenced by ecological conditions and density of populations. Some mono-varietal populations of the var. *coulteri* have decumbent-spreading stems. The var. *coulteri* also has larger flowers, a denser inflorescence, and fruits in irregular fasciculate clusters, whereas the var. *palmeri* usually has minute flowers, and well-spaced, smaller fruits, the clusters much less pronounced. Plants are most often present in monomorphic populations representing only one variety. The flower of *B. coulteri* var. *palmeri* is illustrated in Spellenberg (2000, fig. 1), but is labelled as *B. torreyana*; the complex was not understood at the writing of that article.

Inflorescences of all the spicate species (*B. coulteri* included) I have observed are visited by various insects in the morning when flowers are open and producing nectar, the insects moving from inflorescence to inflorescence, and from plant to plant. Larger-flowered species are visited more frequently (Spellenberg 2000). In mixed populations, particularly, inter-taxon pollination is very likely, and hybridization is presumed possible. Both varieties of *B. coulteri* are weedy, responding positively to disturbance, and with the advent of increased human impact in arid areas of the Southwest, may have come into increased contact.

Boerhavia coulteri var. *coulteri* is geographically the more restricted of the two varieties in the southwestern United States (ranges in Mexico have not been determined), occurring from the eastern to the western borders of Arizona, south of the Mogollon Rim. A population discovered in south-central New Mexico in a well-collected area and may be the result of a recent introduction (N.M., Doña Ana Co., e Las Cruces along University Ave. e of Telshor Drive, 1 km e of IH-25, in gravel planting strip between sidewalk and road, 24 Aug 2001, *Spellenberg and Brouillet 13267*, DUKE, MT, NMC). The var. *palmeri* occurs throughout the Sonoran region in the United States, from southeastern California to southeastern Arizona. It occurs on Santa Catalina Island in the Channel Islands of California (Standley, 1909, cited as *B. watsoni*, *Orcutt s.n.*, 12 Sep. 1889, US!)., where it may have been introduced. In Texas the var. *palmeri* is known from a few collections on or near the Río Grande, the eastern most being from the eastern side of present day Big Bend National Park (*M. S. Young, s.n.*, muddy

bank of Río Grande, near San Vicente [5 mi SW of Boquillas], 26 Aug 1915, TEX [2], LL [1]). On one of these Texas collections, all identified originally as *B. torreyana*, is pencilled, "but looks just like *B. spicata* Choisy Arizona," the writer probably alluding to its similarity to *B. coulteri* var. *palmeri* of Arizona, as here recognized. Because this is the first report of this taxon for Texas, the two other collections seen are cited here: *L.C. Hinckley 1505*, Presidio Co., Capote Canyon 1 mi. below falls, 28 May 1941, US; *C.H. Muller 8438*, Presidio Co., along washes of rolling Río Grande Plain, 4 mi SE of Ruidosa, 28 Jul 1945, LL. In southwestern New Mexico the var. *palmeri* is occasional and weedy; in the vicinity of Las Cruces it is always in disturbed areas. It may be introduced there, but if so, it is long-established in the region (e.g., *Wooton & Standley 3905*, NM, Doña Ana Co., mesa W of Organ Mts., 4000 ft, 5 Oct 1907, LL, TEX, US).

The spicate taxa of *Boerhavia* in the United States may be distinguished by the following key. In this key the range of fruit length-to-width ratios is given in the format (length/diam. = 1.3–2.1).

1. Fruits usually 4-angled (rarely 5-angled), broadly obovoid (length/diam. = 1.3–2.1); branches of inflorescence usually densely glandular villous, without sticky internodal bands _____ **B. wrightii** A. Gray
1. Fruits 5-angled, broadly to narrowly obovoid (length/diam. = 1.7–3.1); branches of inflorescence glabrate to puberulent but not glandular, usually with sticky internodal bands.
2. Surface of sulci of mature fruit papillose, otherwise smooth or somewhat rugose, the edges of the ridges along sulci strongly rugose _____ **B. torreyana**
2. Surface of sulci not papillose, instead smooth or sometimes rugose, the edges of the ridges along sulci not rugose to strongly rugose
3. Fruits broadly obovoid (length/diam. = 1.7–2.1), usually overlapping in inflorescence; sulci and ribs slightly rugose; sulci usually about 0.5 times as wide as base of ribs _____ **B. spicata**
3. Fruits narrowly obovoid or obpyramidal (length/diam. – 2.1–3.1), overlapping in inflorescence or remote; sulci and ribs slightly rugose to smooth; sulci 0.1–0.2 times as wide as base of ribs.
4. Inflorescence with fruits often overlapping 50 100% of their length, commonly ± fasciculate in groups of 2–4, each fruit 2.5–3.6 mm long, truncate, round-truncate, bluntly conic, or round apically _____ **B. coulteri** var. **coulteri**
4. Inflorescence with fruits remote or some overlapping 1–50% of their length, infrequently 2–3 in a cluster, each fruit 2–2.4 mm long, occasionally longer, usually rounded apically _____ **B. coulteri** var. **palmeri**

ACKNOWLEDGMENTS

I acknowledge with gratitude the help of Brian Stannard (K), who sent photocopies and a photographic print of the holotype of *Senkenbergia coulteri* Hook. f. I also thank curators of herbaria who loaned specimens for this study, and to Richard Felger for various e-mail "chats" regarding this taxon.

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BOOK REVIEW

RICHARD L. DUBLE. 2001. **Turfgrasses: Their Management and Use in the Southern Zone, Second Edition.** (ISBN 1-58544-161-9, pbk.) Texas A&M University Press. John H. Lindsey Building, Lewis Street, 4354 TAMU, College Station, TX 77843-4354. (Orders: www.tamu.edu/upress, 979-458-3982, 800-826-8911, 979-847-8752 fax). $27.95, 336 pp, 51 color photos, 15b/w photos, 68 line drawings, 7" × 9".

Although monotypic plantings of an exotic grass species might evoke fear or loathing in those concerned with biodiversity, few would dispute the impact turfgrasses have on our economy or our quality of life. Gulf courses, municipal parks, residential landscapes and interstate roadways are all dependent in some form on turfgrass culture and management. *Turfgrasses* capitalizes on their importance and seeks to provide comprehensive information on how to grow and maintain lawns.

This volume comprises a revision of first edition in 1989. Chapters include the contributions of turfgrasses, the turfgrass plant, growth and development of turfgrasses, southern turfgrasses, specification for turfgrass establishment, cultural practices, weed control in turf, turfgrass diseases, managing turfgrass insects and turfgrass maintenance programs. The second chapter gives a brief, yet clear introduction to grass morphology. In following chapter, Duble elaborates on the growth and development of turfgrasses, covering such topics as seed germination, dormancy and vigor, leaf growth and thatch, and cultural practices affecting root growth. Chapter four is devoted exclusively to southern turfgrasses, dividing them into warm-season and cool-season. For each group of grasses (example: Bermudagrass), he includes information on the origin and distribution of species, a species description, adaptation and uses, horticultural varieties, propagation, management and pest problems. Within the chapter on cultural practices, the author includes obvious topics like mowing, water management and fertilization. A handy worksheet for water budgeting guides the reader in estimating total cost for irrigation. Special cultural practices address vertical mowing, aerification, spiking and topdressing, to name a few. The section on weed control identifies undesirable plants in turf with both descriptions and line drawings and suggests herbicides for control. After reading this book, one should be able to identify and treat turf diseases and insects since the chapters pertaining to these topics seem comprehensive. The final chapter has the commercial turf manager in mind with topics like putting greens and playing fields.

Overall, this is a well-written and thorough tome. I have but a few quibbles. First, many of the references cited seem a bit dated. I noticed only a handful of the citations were published after 1990 with the majority published before 1980. Thus, it seems that some of the material presented herein is outdated. Turfgrass is big business and big money and the demand for current information should be reflected with research. While the both the black and white and color photos are clear and representative, the line drawings of turfgrass species and turf weeds are of poor quality. The drawing of a staminate Buffalograss (p. 72), for instance, could easily be mistaken for *Bouteloua* and Kentucky bluegrass (p.84) looks more like Johnsongrass. It is likely that the target audience would not be familiar with all the species discussed in this book. A clear illustration could be a strong confirmation tool for identification.

This book is appropriately written with the commercial turfgrass manager in mind. Those working in this field should not be without a copy of this book.—*Amy Trauth Nare, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A., amy_trauth@yahoo.com*

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LECTOTYPIFICATION OF *MENTZELIA TEXANA* AND *M. LINDHEIMERI* (LOASACEAE) WITH AN ASSESSMENT OF THEIR BIOLOGICAL STATUS

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In their monograph of the family Loasaceae, Urban and Gilg (1900) treated the genus *Mentzelia* as having 36 taxa, two of these, *M. lindheimeri* and *M. texana*, proposed as new. The purpose of the present paper is to typify each and provide an evaluation of their biologic status.

Mentzelia lindheimeri Urban & Gilg, Monogr. Loas. 54. 1900. TYPE: U.S.A. TEXAS: UVALDE CO.: Jun 1885, *Reverchon 1650* (LECTOTYPE, here designated: MO!; ISOLECTOTYPE: US!).

Urban and Gilg in their protologue of this species cited five specimens gathered by five different collectors, three of these from Texas, two from northern Mexico. All of the specimens cited by these two authors were said to be from European herbaria, namely "Berol., Boisser-Barbey, Canby, Lips., Paris., J.D. Smith, Vindobon." I have examined duplicates of all of the sheets concerned and select the following from among these as adequate lectotypes: U.S.A. Texas: Uvalde Co.: Jun 1885, *Reverchon 1650* (lectotype: MO!; isolectotype: US!). Darlington (1934) also listed this collection as belonging to his concept of *M. lindheimeri*. Urban and Gilg listed the locality of *Reverchon 1650* as "in planitiebus arenosus montis Upper Guadelupe" but the locality on the lectotype is that given here.

Ideally, a lectotype should be selected from among the specimens examined by its original author or authors, but the European collections cited by Urban and Gilg, who worked out of the herbarium at Berlin (B), were unavailable to me. Because of this, I find it appropriate (as permissible under Art 9.10 of the current Code), to designate lectotypes from American syntypes. I have also applied this same reasoning in the typification of the following taxon.

Mentzelia texana Urban & Gilg, Monogr. Loas. 52. 1900. Without specific locality, May–Oct, 1849, *Wright 210* (LECTOTYPE, here designated: GH; ISOLECTOTYPES: GH, US).

In the protologue of this taxon, which I consider to be a synonym of *M. lindheimeri*, Urban and Gilg noted that, so far as known, it was confined to

Texas, citing three specimens: *Drummond 91* (from sandy soils between Victoria and Gonzales, Texas; *Trecul 1220* (dry sites between Turkey Creek and the San Pedro [Devils River]; and *Wright 210* (in part, mixed with *M. oligosperma* Nutt.). They also noted that material of their new species, presumably those cited, were based upon specimens " in herb. Berol., Boisser-Barbey, Candolle, Delessert, Kew., Paris., Vindobon."

Darlington (1934) retained the species, citing two of the above mentioned type elements (*Drummond 202* and *Wright 202*). She also cited three additional specimens from the state of Pueblo, Mexico. I take the latter to be misidentifications of the more southern *M. hispida* Willd., or some close relative having relatively short petals. Correll and Johnston (1970), following Darlington, retained *M. texana* in their treatment of *Mentzelia* for the flora of Texas.

In a recent study of *Mentzelia* for Texas I have examined duplicates of two of the three collections cited by Urban and Gilg in their protologue (*Drummond 91* and *Wright 210*) and have selected *Wright 210* as an appropriate element for lectotypification, largely because duplicate specimens of this collection are currently housed at GH! and US!

The type locality of *M. texana* is moot. According to label data on *Wright 210* (US!) the specimen concerned was collected "May–Oct, 1849." But other than this time span, no other information relating to its collection is given. According to Johnston (1940), on June 28, 1849, Charles Wright collected an unnamed species of *Mentzelia* (Wright's field number *541*) on the hills of Turkey Creek in western Uvalde County. Since Gray often renumbered and/or combined Wright's collections (cf. Johnston 1940), it is likely that *Wright 210* is the number assigned by Gray to Wright's field collection *541*; at least I encountered no Wright collection so numbered in the present study.

The positioning of *M. texana* in synonymy with the simultaneously published *M. lindheimeri* is based upon the study of numerous specimens from ten or more herbaria, and field work over a number of years in the areas concerned. Urban and Gilg, in their key to species, distinguished *M. texana* from *M. lindheimeri* by its shorter petals (7–9 mm vs. 12–14 mm) and sessile or shortly pedicellate fruits (vs always clearly pedicellate). I find these two quantitative characters to be quite variable within the *M. lindheimeri* complex and have little hesitancy in reducing *M. texana* to synonymy. Finally, it should be noted that Darlington (1934) listed the lectotype of *M. texana* (*Wright 210*) among his "Specimens examined:" as a sheet of *M. lindheimeri*, which agrees with the present authors disposition.

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Book Received/Notice

Annotations and comments by the Editor

Daphne Gail Fautin, Douglas J. Futuyma, and H. Bradley Shaffer (eds). 2001. **Annual Review of Ecology and Systematics. Volume 32, 2000**. (ISBN 0-8243-1432-8, hbk; ISSN 0066-4162). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (Orders: www.AnnualReviews.org, 800-523-8635, 650-493-4400, 650-424-0910 fax). $140.00 hbk., 614 pp. 6" × 9".

Readers of *Sida* will find a few articles of interest in this *Annual Review of Ecology and Systematics*. Volume 32 for the year 2001 has 19 articles followed by a Subject Index, Cumulative Index of Contributing Authors, and Cumulative Index of Chapter Titles (Vols. 28–32).

Contents.—

1. Chemical detection of natural enemies by arthropods: An ecological perspective
2. Sex chromosome meiotic drive
3. Environmental influences on regional deep-sea species diversity
4. The physiology of life history trade-offs in animals
5. Urban ecological systems: Linking terrestrial ecological, physical, and socioeconomic components of metropolitan areas
6. Dispersal in freshwater invertebrates
7. Applied evolution
8. Mistletoe—a Keystone resource in forests and woodlands worldwide
9. The role of disturbance in the ecology and conservation of birds
10. Approaches to the study of territory size and shape
11. The population biology of invasive species
12. Streams in the urban landscape
13. Integrating function and ecology in studies of adaptation: Investigations of locomotor capacity as a model system
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NOMENCLATURAL CHANGES AND INNOVATIONS IN *PANICUM* AND *DICHANTHELIUM* (POACEAE: PANICEAE)

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ABSTRACT

Infrageneric taxa in *Panicum* and *Dichanthelium* have a long history of usage, but at least eight of these taxa have not been validly published previously. The new taxa published here are *Panicum* sect. *Antidotalia*, *P.* sect. *Hemitoma*, *Dichanthelium* sect. *Clandestina*, *D.* sect. *Linearifolia*, *D.* sect. *Macrocarpa*, *D.* sect. *Nudicaulia*, *D.* sect. *Pedicellata*, and *D.* sect. *Strigosa*. Fifty-two new combinations, made for a forthcoming treatment of these two genera, are as follows: *D.* sect. *Angustifolia*; *D.* sect. *Ensifolia*; *D.* sect. *Lancearia*; *D.* sect. *Lanuginosa*; *D.* sect. *Oligosantha*; *D.* sect. *Sphaerocarpa*; *D. aciculare* subsp. *angustifolium*, subsp. *fusiforme*, subsp. *neuranthum*; *D. acuminatum* subsp. *columbianum*, subsp. *fasciculatum*, subsp. *implicatum*, subsp. *leucothrix*, subsp. *lindheimeri*, subsp. *longiligulatum*, subsp. *sericeum*, subsp. *spretum*, subsp. *thermale*; *D. chamaelonche* and subsp. *breve*; *D. commutatum* subsp. *ashei*, subsp. *equilaterale*, subsp. *joori*; *D. dichotomum* subsp. *lucidum*, subsp. *mattamuskeetense*, subsp. *microcarpon*, subsp. *nitidum*, subsp. *roanokense*, subsp. *yadkinense*; *D. ensifolium* subsp. *curtifolium*; *D. oligosanthes* subsp. *scribnerianum*; *D. ovale* subsp. *praecocius*, subsp. *pseudopubescens*, subsp. *villosissimum*; *D. portoricense* subsp. *patulum*; *D. strigosum* subsp. *glabrescens*, subsp. *leucoblepharis*; *D. tenue*; *P. amarum* subsp. *amarulum*; *P. anceps* subsp. *rhizomatum*; *P. capillare* subsp. *hilmanii*; *P. dichotomiflorum* subsp. *bartowense*, subsp. *puritanorum*; *P. hallii* subsp. *filipes*; *P. hirticaule* subsp. *sonorum*, subsp. *stramineum*; *P. philadelphicum* subsp. *gattingeri*, subsp. *lithophilum*; and *P. rigidulum* subsp. *abscissum*, subsp. *combsii*, subsp. *elongatum*, subsp. *pubescens*.

RESUMEN

Los táxones infragenéricos en *Panicum* y *Dichanthelium* han sido usados durante mucho tiempo, pero por lo menos ocho de estos táxones no han sido publicados válidamente. Los nuevos táxones aquí publicados son *Panicum* sect. *Antidotalia*, *P.* sect. *Hemitoma*, *Dichanthelium* sect. *Clandestina*, *D.* sect. *Linearifolia*, *D.* sect. *Macrocarpa*, *D.* sect. *Nudicaulia*, *D.* sect. *Pedicellata*, y *D.* sect. *Strigosa*. Cincuenta y dos nuevas combinaciones, designadas en un futuro tratamiento de estos dos géneros, son: *D.* sect. *Angustifolia*; *D.* sect. *Ensifolia*; *D.* sect. *Lancearia*; *D.* sect. *Lanuginosa*; *D.* sect. *Oligosantha*; *D.* sect. *Sphaerocarpa*; *D.* sect. *Angustifolia*; *D.* sect. *Ensifolia*; *D.* sect. *Lancearia*; *D.* sect. *Lanuginosa*; *D.* sect. *Oligosantha*; *D.* sect. *Sphaerocarpa*; *D. aciculare* subsp. *angustifolium*, subsp. *fusiforme*, subsp. *neuranthum*; *D. acuminatum* subsp. *columbianum*, subsp. *fasciculatum*, subsp. *implicatum*, subsp. *leucothrix*, subsp. *lindheimeri*, subsp. *longiligulatum*, subsp. *sericeum*, subsp. *spretum*, subsp. *thermale*; *D. chamaelonche* y subsp. *breve*; *D. commutatum* subsp. *ashei*, subsp. *equilaterale*, subsp. *joori*; *D. dichotomum* subsp. *lucidum*, subsp. *mattamuskeetense*, subsp. *microcarpon*, subsp. *nitidum*, subsp. *roanokense*, subsp. *yadkinense*; *D. ensifolium* subsp. *curtifolium*; *D. oligosanthes* subsp. *scribnerianum*; *D. ovale* subsp. *praecocius*, subsp. *pseudopubescens*, subsp. *villosissimum*; *D. portoricense* subsp. *patulum*; *D strigosum* subsp. *glabrescens*, subsp. *leucoblepharis*; *D. tenue*; *P. amarum* subsp. *amarulum*; *P. anceps* subsp. *rhizomatum*; *P. capillare* subsp. *hilmanii*; *P. dichotomiflorum* subsp. *bartowense*, subsp. *puritanorum*; *P. hallii* subsp. *filipes*; *P. hirticaule* subsp. *sonorum*, subsp. *stramineum*; *P. philadelphicum* subsp. *gattingeri*, subsp. *lithophilum*; y *P. rigidulum* subsp. *abscissum*, subsp. *combsii*, subsp. *elongatum*, subsp. *pubescens*.

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In preparing the treatment of *Panicum* and *Dichanthelium* for Volume 25 of *The Flora of North America* (Barkworth et al. [eds.], in prep.), we find it necessary to describe eight new infrageneric taxa and make fifty-two new combinations. Editorial policy for this volume requires that infraspecific taxa be treated as subspecies rather than as varieties.

INFRAGENERIC NAMES

The genus *Panicum*, as recognized by Linnaeus (1753), included 20 species in two groups: *Spicata* and *Paniculata*. Most of these species have been tranferred subsequently to other genera, including *Digitaria*, *Echinochloa*, *Oplismenus*, *Paspalum*, *Pennisetum*, and *Setaria*. The segregation of *Dichanthelium* from *Panicum* by Gould (1974) on characters of anatomy and photosynthetic pathways is supported by a recent molecular phylogeny of the Panicoideae (Giussani et al. 2001).

Bentham and Hooker (1883) treated *Panicum* as a relatively broad genus and published several infrageneric taxa. Nash (1903) treated *Panicum* in a narrower sense. He named and described nine unranked groups of *Panicum* in Small, *Flora of the Southeastern United States*. Even though no infrageneric rank was indicated, these names were validly and effectively published, and eight of these names can serve as basionyms in *Panicum* or *Dichanthelium*. Hitchcock revised the Gramineae for Robinson and Fernald (1908) in *Gray's Manual of Botany, ed. 7*. He divided *Panicum* in this treatment into two sections, the rank indicated by the double-s sign, which Robinson and Fernald define on p. 32 as indicating a section. He divided section *Eupanicum* into six unranked names, presumably subsections, and added 14 names, presumably series, within the "subsection" *Dichotoma*. Although these 20 infrasectional names are unranked, these names were also validly published and can also serve as basionyms.

Hitchcock and Chase (1910) added 13 additional unranked groups in *Panicum* and effectively published descriptions of these groups. Several subsequent taxonomists (e.g. Fernald 1936, 1938, 1947; Hsu 1965) have treated their group names as sectional or subsectional names. Hitchcock and Chase, however, explicitly stated (page 17) that they did not consider these groups to be formal taxonomic entities. They used the same group names in their later publications (Hitchcock 1913, 1915, 1935, 1951; Hitchcock and Chase 1915) but never suggested that they had changed their minds with respect to the taxonomic status of the groups. Article 34.1 of the *International Code of Botanical Nomenclature* (Greuter et al. 2000) states that a name is not validly published when it is not accepted by the author in the original publication. It seems likely that, had Hitchcock changed his mind regarding these group names, he or Chase would have included that information in one of their later publications for Hitchcock was a very active participant in the development of the nomenclatural code (Hitchcock 1919; Lawrence 1951) and hence must have been aware of the need

to make a clear statement of such a change of mind. Therefore, if the Hitchcock and Chase groups added in the 1910 paper are to be recognized as formal taxa, they must subsequently be validly published. We have indicated that we are deriving our section names from these group names in the 1910 paper by using "Hitchcock & Chase ex Freckmann & Lelong" for those groups which retain the Hitchcock and Chase group name and circumscription.

Pilger (1931) named new sections in *Panicum*, indicating these as "*nov. sect.*," meeting all requirements that apply to a 1931 publication. He also apparently published validly, but inadvertently, as sections two of the Hitchcock and Chase groups by reference to the Hitchcock and Chase names in the 1910 and 1915 papers, even though he did not indicate these as "*nov. sect.*"

Hsu (1965) is often cited as validating Hitchcock and Chase names or as publishing new combinations based on these names, but no types were cited, as required after 1 January 1958 by Article 37.1 of the Code. Gould (1974) raised subgenus *Dichanthelium* to a genus, making new combinations for 17 species and three varieties, but he did not treat subgenera or sections. Brown in Brown and Smith (1975) elevated two sections of *Panicum* to subgenus status in *Dichanthelium*. Zuloaga (1987) returned to a broader concept of *Panicum* and published four new sections, each with a Latin description and citation of a type. He also changed the status of three of Hitchcock's group names to sections, citing types and validly publishing these names.

NEW TAXA

Panicum sect. **Antidotalia** Freckmann & Lelong, sect. nov. TYPUS: *Panicum antidotale* Retz.

Plantae perennes rhizomatibus crassis. Culmi erecti duri robusti, e nodis medius ramosi. Ligulae mebranaceae ciliatae. Paniculae pyramidalis, plus minusve laxae, multiflorae, spiculis distincte pedicellatis. Spiculae ovoideae glabrae; gluma inferior circa dimidiam longitudinem spiculae attingens, 3–5 nervia; gluma superior et lemma inferior 7-nervia; anthoecium inferius staminiferis; anthoecium superius glabrum, nitidum.

Plants perennial, with thick rhizomes. Culms erect, robust, hard, branching at the middle nodes. Ligule a ciliate membrane. Panicle pyramidal, more or less lax, many-flowered, with spikelets on long pedicels. Spikelets ovoid, glabrous; first glume about 1/2 as long as the spikelet, 3- or 5-nerved; second glume and lower lemma 7-nerved; lower floret staminate; upper floret smooth, shiny. x = 9.

Panicum sect. **Hemitoma** Hitchc. & Chase ex Freckmann & Lelong, sect. nov. TYPUS: *Panicum hemitomon* Schult.

Plantae perennes rhizomatibus, plus minusve aquaticae. Culmi erecti vel reclinati, saepe sterilis. Ligulae membranaceae, ciliatae vel laceratae. Paniculae angustae; rami pauci erecti spiciformes spiculis secundis subsesillibus. Spiculae anguste ovoideae vel lanceolatae lateraliter compressae, glabrae. Anthoecium inferius staminiferis; lemma superior tenuis, flexilibus, albida, involuta non nisi prope basin.

Plants perennial, semi-aquatic, with extensive rhizomes or stolons. Culms erect or sprawling, often sterile. Ligule a ciliate or lacerate membrane. Panicle narrow; branches few, spiciform, erect, with subsessile to short-pedicelled, secund spikelets. Spikelets narrowly ovoid to lanceolate, laterally compressed, glabrous. Lower floret staminate; upper lemma thin, flexible, whitish, rolled over the palea only near the base.

Dichanthelium sect. **Clandestina** Freckmann & Lelong, sect. nov. TYPUS: *Panicum clandestinum* L.

Plantae perennes rhizomatibus crassis vel caudicibus. Culmi 50–150 mm alti; culmi autumnali e nodis medius et superioribus ramosi, ramulosi, saepe fasciculos axillares formantes, paniculis clandestinis intra foliorum vaginas. Folia basilaria rosulam hiemalem formantes. Vagina tumida, maculata, papillosa-hispida vel pubescentia et viscida, ore constricta. Lamina basilaria grandis, ovata-lanceolata; laminae caulinae 6–14. Spiculae ellipsoideae vel ovoideae, acutae, 2.2–3.6 mm longa, nervis prominibus.

Plants perennial, from a thick rhizome or caudex. Culms 50–150 cm; autumnal culms with branches arising from the middle and upper nodes, rebranching and often forming dense axillary fascicles, the panicles enclosed in the sheaths. Basal leaves forming a winter rosette. Sheath usually swollen, mottled, papillose-hispid or pubescent and viscid, constricted at summit; basal blades large, ovate-lanceolate; cauline blades 6–14. Spikelets ellipsoid to ovoid, pointed, 2.2–3.6 mm long, with prominent veins.

Dichanthelium sect. **Linearifolia** Freckmann & Lelong, sect. nov. TYPUS: *Panicum linearifolium* Scribn. ex Nash.

Plantae perennes caespitosae. Culmi erecti vel effusi vel cernui; internodia inferna brevissima; internodia supera saepe manopere elongata. Culmi autumnali e nodis prope basin ramosi, paniculas condensatas minus quam 5 cm super terram vel culmos steriles formantes. Laminae basilares angustae, erectae vel ascendes, laminas caulinas infernas simulans; laminae superae plerumque erectae, rigidae, 1–5 mm latae, 15–60 ·plo longiora quam latiora. Spiculae ovoideae, ellipsoideae, vel obovoideae, 2.0 ·4.3 mm longa, glabrae vel pubescentae.

Plants perennial, tufted. Culms erect to spreading or drooping, the lower internodes very short, the upper 2–4 internodes often much elongated. Autumnal culms branching from the nodes near the base, producing condensed panicles within about 5 cm of the ground or sterile shoots. Basal blades narrow, erect or ascending, resembling the lower cauline ones; cauline blades usually erect, stiff, the upper ones 1–5 mm wide and 15–60 times as long. Spikelets ovoid, ellipsoid, or obovoid, 2.0–4.3 mm long, glabrous or pubescent.

Hitchcock and Chase (1910) used the group name "Depauperata" for most of the species in this section. However, because Pilger (1931) published section *Depauperata* for certain Old World species of *Panicum* and because *Dichanthelium* is often included in *Panicum*, we prefer to avoid creating a homonym if these genera are combined.

Dichanthelium sect. **Macrocarpa** Freckmann & Lelong, sect. nov. TYPUS: *Panicum macrocarpon* LeConte ex Torr.

Plantae perennes rhizomatibus brevibus vel caudicibus, raro rhizomatibus elongatibus. Culmi principales 20–110 cm alti, plus minusve erecti, sparse ramosi, fasciculos axillares densos non faciens; culmi secundarii interdum autumnali, parviores. Folia basilaria rosulam hiemalem formantes. Foliorum vaginae glabrae vel pubescentiae, non viscidae; laminae caulinae 3–7. Paniculae saltem partim exsertae. Anthoecium inferius saepe staminiferis.

Plants perennial, from a knotted rhizome, a caudex, or rarely an elongated rhizome. Main culms 20–110 cm, ascending to erect, sparsely rebranching, not producing dense axillary fascicles; additional culms (sometimes arising in autumn) smaller. Basal leaves forming a winter rosette. Sheaths glabrous or pubescent, not viscid; cauline blades 3–7. Panicle at least partly exserted. Lower floret often staminate.

Nash (1903) published the infrageneric name *Latifolia* within *Panicum*, indicating that this name was based on *Panicum latifolium* L. However, it is evident from his description ("much branched shrubs...outer [spikelet] scales woolly-tipped") that this name was based on a misapplication of *Panicum latifolium*, referring instead to *Panicum* (=*Lasiacis*) *divaricatum* L. According to Art. 7.4 of the Code a name is typified by the type of the basionym, even though it may have been applied to a taxon now considered not to include that type. However, in the case of an unranked infrageneric name, a modern author may publish a new name at a definite rank. We prefer to avoid confusion over the application of *Latifolia* by basing this section name on a different type.

Dichanthelium sect. **Nudicaulia** Hitchcock & Chase ex Freckmann & Lelong, sect. nov. TYPUS: *Panicum nudicaule* Vasey.

Plantae perennes caesptosae. Culmi 20–60 cm alti, inferme ascendes, glabri; culmi autumnale e nodis prope basin ramosi. Laminae planae vel rigide involutae, ascendes, basi aggregatae, superiores multum redactae. Folia basilaria rosulam hiemalem formantes. Panicula longa-exserta, pauciflora. Spiculae anguste ellipsoideae, 2.4–2.9 mm longa, glabrae.

Plants perennial, tufted. Culms 20–60 cm, weakly ascending, glabrous; autumnal culms branching from the base. Blades flat to stiffly involute, ascending, crowded at the base, the uppermost ones much reduced. Basal leaves not forming a distinct winter rosette. Panicle long-exserted, few-flowered. Spikelets narrowly ellipsoid, 2.4–2.9 mm long, glabrous.

Dichanthelium sect. **Pedicellata** Hitchc. & Chase ex Freckmann & Lelong, sect. nov. TYPUS: *Panicum pedicellatum* Vasey.

Plantae perennes basibus duris cormiformibus et rhizomatibus gangliiformibus. Culmi erecti vel effusi; culmi autumnali divaricate ramosi ante maturitem paniculae ad finem decumbes. Folia basilaria rosula hiemalem non formantes. Ligulae membranaceae ciliatae. Laminae papillatae ciliatae. Spiculae obovoideae vel obpyriformes, 3.2–4.4 mm longa, papillatae pubescentae, basi attenuatae. Anthoecium superius ad apicem puberulum, acutum vel attenuatum.

Plants perennial, from a hard, corm-like base and a knotted rhizome. Culms

erect or spreading; autumnal culms freely divaricate-branching before the primary panicle matures, ultimately decumbent. Basal leaves not forming a winter rosette. Ligule a ciliate membrane. Blades papillose-ciliate. Spikelets obovoid to obpyriform, 3.2–4.4 mm long, papillose-pubescent, attenuate at the base. Upper floret pointed to attenuate, puberulent at the apex.

Dichanthelium sect. **Strigosa** Freckmann & Lelong, sect. nov. TYPUS: *Panicum strigosum* Muhl. in Elliott.

Plantae perennes dense caespitosae. Culmi principales graciles; internodia inferna breves; 3–5 internodia supera elongata. Culmi autumnali pulvinum densum formantes. Laminae molles pallidovirens vel flavovirens, plerumque marginibus ciliatis. Laminae basilares grandes laminas caulinas infernas simulans. Spiculae late ellipsoideae vel obovoideae, 1.1–2.3 mm longa, glabrae vel pubescentae.

Plants perennial, densely tufted. Main culms slender, the lower internodes short, the upper 3–5 internodes elongated. Autumnal culms forming a dense cushion. Blades soft, pale green or yellowish, usually with ciliate margins. Basal blades large, scarcely separable from the lower cauline blades. Spikelets broadly ellipsoid to obovoid, 1.1–2.3 mm long, glabrous to pubescent.

Bentham and Hooker (1883) created the section *Laxiflora* to include certain Old World species of their subgenus *Eupanicum*, but not including *P. laxiflorum* Lam. To avoid creating a later homonym if *Dichanthelium* is treated as part of *Panicum*, we are basing the section name on *Panicum strigosum* Muhl. in Elliott, rather than *P. laxiflorum*.

NEW COMBINATIONS

Dichanthelium sect. **Angustifolia** (Hitchc. in B.L. Rob. & Fernald) Freckmann & Lelong, stat. nov. BASIONYM: *Panicum* (unranked) *Angustifolia* Hitchc. in B.L. Rob. & Fernald, Gray's Man. Bot. Ed. 7:106. 1908. TYPE: *Panicum angustifolium* Elliott.

Dichanthelium sect. **Ensifolia** (Hitchc.in B.L. Rob. & Fernald) Freckmann & Lelong, stat. nov. BASIONYM: *Panicum* (unranked) *Ensifolia* Hitchc. in B.L. Rob. & Fernald, Gray's Man. Bot, ed. 7:113. 1908. TYPE: *Panicum ensifolium* Baldwin ex Elliott.

Dichanthelium sect. **Lancearia** (Hitchc. in B.L. Rob. & Fernald) Freckmann & Lelong, stat. nov. BASIONYM: *Panicum* (unranked) *Lancearia* Hitchc. in B.L. Rob. & Fernald, Gray's Man. Bot, ed. 7:114. 1908. TYPE: *Panicum lancearium* Trin.

Dichanthelium sect. **Lanuginosa** (Hitchc. in B.L.Rob. & Fernald) Freckmann & Lelong, stat. nov. BASIONYM: *Panicum* (unranked) *Lanuginosa* Hitchc. in B.L. Rob. & Fernald, Gray's Man. Bot, ed. 7:109. 1908. TYPE: *Panicum lanuginosum* Elliott.

Dichanthelium sect. **Oligosantha** (Hitchc. in B.L.Rob. & Fernald) Freckmann & Lelong, stat. nov. BASIONYM: *Panicum* (unranked) *Oligosanthia* Hitchc. in B.L. Rob. & Fernald, Gray's Man. Bot, ed. 7:114. 1908. TYPE: *Panicum oligosanthes* Schult.

Dichanthelium sect. **Sphaerocarpa** (Hitchc. in B.L.Rob. & Fernald) Freckmann & Lelong, stat. nov. BASIONYM: *Panicum* (unranked) *Sphaerocarpa* Hitchc. in B.L. Rob. & Fernald, Gray's Man. Bot, ed. 7:113. 1908. TYPE: *Panicum sphaerocarpon* Elliott.

Dichanthelium aciculare subsp. **angustifolium** (Elliott) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum angustifolium* Elliott, Sketch Bot. S. Carolina & Ga. 1:129. 1816. *Panicum nitidum* var. *angustifolium* (Elliott) A. Gray, N. Amer. Gram. 2:112. 1835. *Chasea angustifolia* (Elliott) Nieuwl., Amer. Midl. Naturalist 2:64. 1911. *Dichanthelium angustifolium* (Elliott) Gould, Brittonia 26:59. 1974. *Panicum aciculare* var. *angustifolium* (Elliott) Wipff & S.D. Jones, Phytologia 77:457. 1994. TYPE: U.S.A. SOUTH CAROLINA: May, *S. Elliott s.n.* (HOLOTYPE: CHARL, fragment US!).

Dichanthelium aciculare subsp. **fusiforme** (Hitchc.) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum fusiforme* Hitchc., Contr. U.S. Natl. Herb. 12:222. 1909. *Dichanthelium fusiforme* (Hitchc.) Harvill, Castanea 42:177. 1977. TYPE: CUBA: western Cuba, 1863, *C. Wright 3454* (HOLOTYPE: GOET, fragment US!).

Panicum neuranthum var. *ramosum* Griseb., Cat. Pl. Cub. 232. 1866. *Dichanthelium aciculare* var. *ramosum* (Griseb.) Davidse, Novon 2:104. 1992.

Dichanthelium aciculare subsp. **neuranthum** (Griseb.) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum neuranthum* Griseb., Cat. Pl. Cub. 232. 1866. TYPE: CUBA: eastern Cuba, 1860, *C. Wright 3453* (HOLOTYPE: US 2209346!).

Panicum pinetorum Swallen, Proc. Biol. Soc. Wash. 55:93. 1942.

Dichanthelium acuminatum subsp. **columbianum** (Scribn.) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum columbianum* Scribn., U.S.D.A. Div. Agrost. Bull. 7:78, f. 6. 1897. *Dichanthelium columbianum* (Scribn.) Freckmann, Phytologia 39:270. 1978. *Panicum acuminatum* var. *columbianum* (Scribn.) Lelong, Brittonia 36:270. 1984. TYPE: U.S.A. DISTRICT OF COLUMBIA: 14 Jul 1894 *F.L. Scribner s.n.* (HOLOTYPE: US 743463!).

Dichanthelium acuminatum subsp. **fasciculatum** (Torr.) Freckmann & Lelong, comb & stat.. nov. BASIONYM: *Panicum dichotomum* var. *fasciculatum* Torr., Fl. North. & Mid. U. S. 1:145. 1824. *Panicum huachucae* var. *fasciculatum* (Torr.) F.T. Hubb., Rhodora 14:171. 1912. *Panicum lindheimeri* var. *fasciculatum* (Torr.) Fernald, Rhodora 23:228. 1921. *Panicum lanuginosum* var. *fasciculatum* (Torr.) Fernald, Rhodora 36:77. 1934. *Dichanthelium lanuginosum* var. *fasciculatum* (Torr.) Spellenb. Madroño 23:145. 1975. *Dichanthelium acuminatum* var. *fasciculatum* (Torr.) Freckmann, Phytologia 48:108. 1981. *Panicum acuminatum* var. *fasciculatum* (Torr.) Lelong, Brittonia 36:269. 1984. TYPE: U.S.A. NEW JERSEY: sandy fields, *J. Torrey s.n.* (HOLOTYPE: NY!).

Dichanthelium acuminatum subsp. **implicatum** (Scribn. ex Nash) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum implicatum* Scribn. ex Nash in Britton & A. Br., Illust. Fl. 3:498, f. 267a. 1898. *Panicum unciphyllum* var. *implicatum* (Scribn. ex Nash) Scribn. & Merr., Rhodora 3:123. 1901. *Panicum lindheimeri* var. *implicatum* (Scribn. ex Nash) Fernald, Rhodora 23:228. 1921. *Panicum lanuginosum* var. *implicatum* (Scribn. ex Nash) Fernald, Rhodora 36:77. 1934. *Dichanthelium acuminatum* var. *implicatum* (Scribn. ex Nash) Gould & C.A. Clark, Ann. Missouri Bot. Gard. 65:1126. 1979 [imprint date 1978]. *Panicum acuminatum* var. *implicatum* (Scribn. ex Nash) Beetle, Phytologia 48:192. 1981. TYPE: U.S.A. MAINE: low marshy ground, Cape Elizabeth, 26 Jul 1895, *F.L. Scribner s.n.* (HOLOTYPE: US 742896!).

Dichanthelium acuminatum subsp. **leucothrix** (Nash) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum leucothrix* Nash, Bull. Torrey Bot. Club 24:41. 1897. *Dichanthelium leucothrix* (Nash) Freckmann, Phytologia 48:101. 1981.

Panicum acuminatum var. *leucothrix* (Nash) Lelong, Brittonia 36:271. 1984. TYPE: U.S.A. FLORIDA: Lake Co.: low pineland at Eustis, 16-31 Jul 1894, *G.V. Nash s.n.* (HOLOTYPE: NY!).

Dichanthelium acuminatum subsp. **lindheimeri** (Nash) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum lindheimeri* Nash, Bull. Torrey Bot. Club 24:196. 1897. *Panicum lanuginosum* var. *lindheimeri* (Nash) Fernald, Rhodora 36:77. 1934. *Dichanthelium lindheimeri* (Nash) Gould, Brittonia 26:60. 1974. *Dichanthelium lanuginosum* var. *lindheimeri* (Nash) Freckmann, Phytologia 39:270. 1978. *Dichanthelium acuminatum* var. *lindheimeri* (Nash) Gould & C.A. Clark, Ann. Missouri Bot. Gard. 65:1127. 1979 [imprint date 1978]. *Panicum acuminatum* var. *lindheimeri* (Nash) Beetle, Phytologia 48:193. 1981. *Panicum lindheimeri* var. *typicum* Fernald, Rhodora 23:227. 1921. TYPE: U.S.A. TEXAS: springs, banks of the Guadeloupe, near New Braunfels, 1846, *F.J. Lindheimer* 565 (HOLOTYPE: NY!).

Dichanthelium acuminatum subsp. **longiligulatum** (Nash) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum longiligulatum* Nash, Bull. Torrey Bot. Club 26:574. 1899. *Dichanthelium acuminatum* var. *longiligulatum* (Nash) Gould & C.A. Clark, Ann. Missouri Bot. Gard. 65:1127-1128. 1979 [imprint date 1978]. *Dichanthelium longiligulatum* (Nash) Freckmann, Phytologia 48:102. 1981. *Panicum acuminatum* var. *longiligulatum* (Nash) Lelong, Brittonia 36:270. 1984. TYPE: U.S.A. FLORIDA: Apalachicola, 1892, *G.R. Vasey* (HOLOTYPE: NY!).

Dichanthelium acuminatum subsp. **sericeum** (Schmoll) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum ferventicola* var. *sericeum* Schmoll, Madroño 5:92. 1939. *Dichanthelium lanuginosum* var. *sericeum* (Schmoll) Spellenb., Madroño 23:150. 1975. *Dichanthelium acuminatum* var. *sericeum* (Schmoll) Freckmann, Phytologia 48:107. 1981. Type: U.S.A. WYOMING: Mammoth Hot Springs, Yellowstone National Park, in wet ground about hot springs, *A. Nelson 6037* (HOLOTYPE: RM 20108).

Dichanthelium acuminatum subsp. **spretum** (Schult.) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum spretum* Schult., Mant. 2:248.1824. *Dichanthelium spretum* (Schult.) Freckmann, Phytologia 48:102. 1981. TYPE: U.S.A. New England, moist ground, Muhlenberg's *Panicum* No. 37 (HOLOTYPE: PH).

Dichanthelium acuminatum subsp. **thermale** (Bol.) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum thermale* Bol., Proc. Calif. Acad. Sci. 2:181. 1862. *Dichanthelium lanuginosum* var. *thermale* (Bol.) Spellenb., Madroño 23:151. 1975. *Dichanthelium acuminatum* var. *thermale* (Bol.) Freckmann, Phytologia 48:107. 1981. TYPE: U.S.A. CALIFORNIA. Sonoma Co.: northern part of Sonoma County, on hot rocks and in hot water flowing from Geyser Springs and Geyser Mountains, *H.N. Bolander 3941* (HOLOTYPE: GH).

Dichanthelium chamaelonche (Trin.) Freckmann & Lelong, comb. nov. BASIONYM: *Panicum chamaelonche* Trin., Gram. Panic. 242. 1826. TYPE: U.S.A. "AMER. BOR.": *Enslin s.n.* (HOLOTYPE: LE; fragment and photograph US!).

Dichanthelium chamaelonche subsp. **breve** (Hitchc. & Chase) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum breve* Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:271. 1910. *Dichanthelium dichotomum* var. *breve* (Hitchc. & Chase) Gould & C.A. Clark, Ann. Missouri Bot. Gard. 65:1120. 1979 [imprint date 1978]. *Panicum chamaelonche* var. *breve* (Hitchc. & Chase) Lelong, Brittonia 36:267.

1984. *Dichanthelium ensifolium* var. *breve* (Hitchc. & Chase) B.F. Hansen & Wunderlin, Ann. Missouri Bot. Gard. 75:1646. 1989 [imprint date 1988]. *Panicum ensifolium* var. *breve* (Hitchc. & Chase) Wipff & S.D. Jones, Phytologia 77:460. 1994. TYPE: U.S.A. FLORIDA: Jensen, low pine woods between scrub hills, among palmetto, 5 Apr 1906, *A.S. Hitchcock 734* (HOLOTYPE: US 558435!).

Dichanthelium commutatum subsp. **ashei** (G. Pearson ex Ashe) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum ashei* G. Pearson ex Ashe, J. Elisha Mitchell Sci. Soc. 15:35 (1898). *Panicum commutatum* var. *ashei* (G. Pearson ex Ashe) Fernald, Rhodora 36:83 (1934). TYPE: U.S.A. NEW YORK: Ithaca, Jul 1898, *W.W. Ashe s.n.* (LECTOTYPE [ISOTYPE] US!, [designated by Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:301. 1910.]).

Dichanthelium commutatum subsp. **equilaterale** (Scribn.) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum equilaterale* Scribn., U.S.D.A. Div. Agrost. Bull. 11:42. 1898. TYPE: U.S.A. FLORIDA: Lake Co.: scrubby hammock lands, Eustis, 16-25 Aug 1894, *G.V. Nash 1674* (LECTOTYPE: US 743929! [designated by Hitchcock & Chase, Contr. U.S. Natl. Herb. 15:310. 1910.])

Dichanthelium commutatum subsp. **joori** (Vasey) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum joori* Vasey, U.S.D.A. Div. Agrost. Bull. 8:31.1889. TYPE: U.S.A. LOUISIANA: East Baton Rouge Par., near Baton Rouge, creek bank, in dense tufts, 1 Oct. 1885, *J.F. Joor 39* (HOLOTYPE: US!). *Panicum divergens* Kunth *in* H.B.K. has been used by Zuloaga et al. (1993) to replace *P. commutatum*. However, Davidse & Zuloaga (2000) in proposing rejection of *P. divergens* note that the provenance of the type collection is uncertain and that the name had never been applied previously to *P. commutatum*.

Dichanthelium dichotomum subsp. **lucidum** (Ashe) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum lucidum* Ashe, J. Elisha Mitchell Sci. Soc. 15:47. 1898. *Panicum dichotomum* var. *lucidum* (Ashe) Lelong, Brittonia 36:265. 1984. *Dichanthelium lucidum* (Ashe) LeBlond, Sida 19(4):831. 2001. TYPE: U.S.A. NORTH CAROLINA: deep shady swamps bordering Lake Mattamuskeet, 10 Jun-6 Jul 1898, *W.W. Ashe s.n.* (LECTOTYPE: fragment US! [designated by Hitchcock & Chase, Contr. U.S. Natl. Herb. 15:198. 1910.]).

Dichanthelium dichotomum subsp. **mattamuskeetense** (Ashe) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum mattamuskeetense* Ashe, J. Elisha Mitchell Sci. Soc. 15:45. 1898. *Panicum dichotomum* var. *mattamuskeetense* (Ashe) Lelong, Brittonia 36:265. 1984. *Dichanthelium mattamuskeetense* (Ashe) LeBlond, Sida 19:832. 2001. TYPE: U.S.A. NORTH CAROLINA: around Lake Mattamuskeet, 10 Jun-6 Jul 1898, *W.W. Ashe and G. Pearson s.n.* (LECTOTYPE: US 2808955! [designated by Hitchcock & Chase, Contr. U.S. Natl. Herb. 15:186. 1910.]).

Dichanthelium dichotomum subsp. **microcarpon** (Muhl. ex Elliott) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum microcarpon* Muhl. ex Elliott, Sketch Bot. S. Carolina 1:127. 1816. TYPE: U.S.A. GEORGIA, *A.A. Baldwin s.n.* (LECTOTYPE: CHARL [designated by Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:181.1910.]).

Dichanthelium dichotomum subsp. **nitidum** (Lam.) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum nitidum* Lam., Tabl. Encycl. 1:172. 1791. *Panicum dichotomum* var. *nitidum* (Lam.) Alph. Wood, Class-book bot., ed. *s.n. [b]*, 786. 1861. *Dichanthelium dichotomum* var. *nitidum* (Lam.) LeBlond, Sida 19(4):829. 2001. TYPE: U.S.A. "CAROLINA": eastern Carolina, *J. Fraser s.n.* (HOLOTYPE: P, fragment US!).

Dichanthelium dichotomum subsp. **roanokense** (Ashe) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum roanokense* Ashe, J. Elisha Mitchell Sci. Soc. 15:44. 1898. *Panicum dichotomum* var. *roanokense* (Ashe) Lelong, Brittonia 36:265. 1984. *Dichanthelium dichotomum* var. *roanokense* (Ashe) LeBlond, Sida 19(4):831. 2001. TYPE: U.S.A. NORTH CAROLINA. Dare Co.: Manteo, Roanoke Island, dry soil, 10 Jun 1898, *W.W. Ashe s.n.* (LECTOTYPE: US![designated by Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:196. 1910]).

Dichanthelium dichotomum subsp. **yadkinense** (Ashe) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum yadkinense* Ashe, J. Elisha Mitchell Sci. Soc. 16:85. 1900. *Panicum dichotomum* var. *yadkinense* (Ashe) Lelong, Brittonia 36:266. 1984. *Dichanthelium yadkinense* (Ashe) Mohlenbr., Erigenia 6:27. 1985. TYPE: U.S.A. NORTH CAROLINA. Raleigh, May 1895, *W.W. Ashe s.n.* (LECTOTYPE: US 2808938! [designated by Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:195. 1910]).

Dichanthelium ensifolium subsp. **curtifolium** (Nash) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum curtifolium* Nash, Bull. Torrey Bot. Club 26:569. 1899. *Panicum ensifolium* var. *curtifolium* (Nash) Lelong, Brittonia 36:266. 1984. TYPE: U.S.A. MISSISSIPPI. Ocean Springs, 2 May 1898, *S.M. Tracy 4598* (HOLOTYPE: NY!).

Dichanthelium oligosanthes subsp. **scribnerianum** (Nash) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum scribnerianum* Nash, Bull. Torrey Bot. Club 22:421. 1895. *Panicum oligosanthes* var. *scribnerianum* (Nash) Fernald, Rhodora 36:80. 1934. *Dichanthelium oligosanthes* var. *scribnerianum* (Nash) Gould, Brittonia 26:60. 1974. TYPE: U.S.A. PENNSYLVANIA. Wysox, Jul 1836, *J. Carey s.n.* (LECTOTYPE: GH [designated by Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:283. 1910]).

Panicum scoparium S. Watson in A. Gray, Man., ed. 6, 632. 1890., *nec* Lam. (1798), *nec* Rudge (1805), *nec* Elliott. (1816).

Dichanthelium ovale subsp. **praecocius** (Hitchc. & Chase) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum praecocius* Hitchc. & Chase, Rhodora 8:206. 1906. *Panicum lanuginosum* var. *praecocius* (Hitchc. & Chase) Dore in McNeill & Dore, Naturaliste Canad. 103:562. 1977. *Dichanthelium villosissimum* var. *praecocius* (Hitchc. & Chase) Freckmann, Phytologia 39:270. 1978. TYPE: U.S.A. ILLINOIS. Stark Co.: dry bank, near Wady Petra, 30 Jun 1900, *V.H. Chase 649* (HOLOTYPE: US 558686!).

Dichanthelium ovale subsp. **pseudopubescens** (Nash) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum pseudopubescens* Nash, Bull. Torrey Bot. Club 26:577. 1899. *Panicum villosissimum* var. *pseudopubescens* (Nash) Fernald, Rhodora 36:79. 1934. *Panicum ovale* var. *pseudopubescens* (Nash) Lelong, Brittonia 36:271. 1984. TYPE: U.S.A. ALABAMA: Lee Co.: Auburn, 7 May 1898, *F.S. Earle and C.F. Baker 1537* (HOLOTYPE: NY!).

Dichanthelium ovale subsp. **villosissimum** (Nash) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum villosissimum* Nash, Bull. Torrey Bot. Club 23:149. 1896. *Dichanthelium lanuginosum* var. *villosissimum* (Nash) Gould, Brittonia 26:60. 1974. *Dichanthelium villosissimum* (Nash) Freckmann, Phytologia 32:270. 1978. TYPE: U.S.A. GEORGIA. Ocmulgee River swamp, below Macon, 18–24 May 1895, *J.K. Small s.n.* (HOLOTYPE: NY!).

Dichanthelium portoricense subsp. **patulum** (Scribn. & Merr.) Freckmann & Lelong, comb. nov. BASIONYM: *Panicum nashianum* var. *patulum* Scribn. & Merr.,

U.S.D.A. Dept. Agrost. Circ. 27:9. 1900. *Panicum patulum* (Scribn. & Merr.) Hitchc., Rhodora 8:209. 1906. *Panicum lancearium* var. *patulum* (Scribn. & Merr.) Fernald, Rhodora 36:80. 1934. *Dichanthelium sabulorum* var. *patulum* (Scribn. & Merr.) Gould & C.A. Clark, Ann Missouri Bot. Gard. 65:1113. 1979 [imprint date 1978]. TYPE: U.S.A. FLORIDA. Manatee Co.: Braidentown [Bradenton], 3 Sep 1898, *R. Combs 1296* (HOLOTYPE: US 2808982!).

Dichanthelium strigosum subsp. **glabrescens** (Griseb.) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum dichotomum* var. *glabrescens* Griseb., Fl. Brit. W.Indies 553. 1864. *Dichanthelium leucoblepharis* var. *glabrescens* (Griseb.) Gould & C.A. Clark, Ann. Missouri Bot. Gard. 65:1100 (1979) [imprint date 1978]. *Dichanthelium strigosum* var. *glabrescens* (Griseb.) Freckmann, Brittonia 33:457. 1981. *Panicum strigosum* var. *glabrescens* (Griseb.) Lelong, Brittonia 36:264. 1984. TYPE: JAMAICA: *W. Purdie s.n.* (HOLOTYPE: K).

Dichanthelium strigosum subsp. **leucoblepharis** (Trin.) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum leucoblepharis* Trin., Clav. Agrost. 234. 1822. *Dichanthelium leucoblepharis* (Trin.) Gould & C.A. Clark, Ann. Missouri Bot. Gard. 65:1099. 1979 [imprint date 1978]. *Dichanthelium strigosum* var. *leucoblepharis* (Trin.) Freckmann, Brittonia 33:457. 1981. *Panicum strigosum* var. *leucoblepharis* (Trin.) Lelong, Brittonia 36:264. 1984. TYPE: U.S.A. NORTH CAROLINA, SOUTH CAROLINA, GEORGIA, LOUSIANA: *Enslin s.n.* (LECTOTYPE: LE, fragment US! [designated by Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:162. 1910]).

Dichanthelium tenue (Muhl.) Freckmann & Lelong, comb. nov. BASIONYM: *Panicum tenue* Muhl., Descr. Gram. 118 (1817). *Dichanthelium dichotomum* var. *tenue* (Muhl.) Gould & C.A. Clark, Ann. Missouri Bot. Gard. 65:1119. 1979 [imprint date 1978]. TYPE: U.S.A.: *Muhlenberg Herb. 192* (LECTOTYPE: PH-M [designated by Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:259. 1910]).

Panicum amarum subsp. **amarulum** (Hitchc. & Chase) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum amarulum* Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:96. 1910. *Panicum amarum* var. *amarulum* (Hitchc. & Chase) P.G. Palmer, Brittonia 27:149. 1975. TYPE: U.S.A. VIRGINIA. Virginia Beach, 24 Sep 1900, *T.A. Williams 3090* (HOLOTYPE: US 592748!).

Panicum anceps subsp. **rhizomatum** (Hitchc. & Chase) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum rhizomatum* Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:109, f. 104. 1910. *Panicum anceps* var. *rhizomatum* (Hitchc. & Chase) Fernald, Rhodora 36:73. 1934. TYPE: U.S.A. SOUTH CAROLINA: Orangeburg, 18 Aug 1905, *A.S. Hitchcock 450* (HOLOTYPE: US 592752!).

Panicum capillare subsp. **hillmanii** (Chase) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum hillmanii* [as "*hillmani*"] Chase, J. Wash. Acad. Sci. 14:345. 1934. TYPE: U.S.A. TEXAS: Amarillo, plain, 11 Aug 1918, *A.S. Hitchcock 16206* (HOLOTYPE: US 1037542!).

Panicum dichotomiflorum subsp. **bartowense** (Scribn. & Merr.) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum bartowense* Scribn. & Merr., U.S.D.A. Dept. Agrost. Circ. 35:3. 1901. *Panicum dichotomiflorum* var. *bartowense* (Scribn. & Merr.) Fernald, Rhodora 38:387. 1938. TYPE: U.S.A. FLORIDA. Polk Co.: in wet reclaimed swamps at Bartow, 29 Sep 1898, *R. Combs 1220* (HOLOTYPE: US 80538!).

Panicum dichotomiflorum subsp. **puritanorum** (Svenson) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum dichotomiflorum* var. *puritanorum*

Svenson, Rhodora 22:154, f. 1-5. 1920. TYPE: U.S.A. MAINE: dry sandy and gravelly beach, Half-way Pond, Barnstable, 13 Sep 1919, *M.L. Fernald 306* (HOLOTYPE: GH).

Panicum hallii subsp. **filipes** (Scribn.) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum filipes* Scribn. *in* A. Heller, Contr. Herb. Franklin Marshall Coll. 1:13. 1895. *Panicum hallii* var. *filipes* (Scribn.) F.R. Waller, South W. Naturalist 19:105. 1974. TYPE: U.S.A. TEXAS: growing in rich shaded ground in the upper part of the arroyo at Corpus Christi, alt. 30 feet, 31 May 1894, *A.A. Heller 1809* (HOLOTYPE: US 2463136!).

Panicum hirticaule subsp. **sonorum** (Vasey) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum sonorum* Vasey *in* Beal, Grasses N. Amer. 2:130. 1896. TYPE: MEXICO. SONORA: Lerdo, at the head of the Gulf of California, 1889, *E. Palmer 947* (HOLOTYPE: US 2903025!).

Panicum capillare var. *miliaceum* Vasey *in* Vasey & Rose, Contr. U.S. Natl. Herb. 1:28. 1890. *Panicum hirticaule* var. *miliaceum* (Vasey) Beetle, Phytologia 47:383. 1981.

Panicum hirticaule subsp. **stramineum** (Hitchc. & Chase) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum stramineum* Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:67, f. 50. 1910. *Panicum capillare* var. *stramineum* (Hitchc. & Chase) Gould, Madroño 10:94. 1949. *Panicum hirticaule* var. *stramineum* (Hitchc. & Chase) Beetle, Phytologia 47:383. 1981. TYPE: MEXICO. SONORA: Guaymas, Jun-Nov 1887, *E. Palmer 206* (HOLOTYPE: US 592753!).

Panicum philadelphicum subsp. **gattingeri** (Nash) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum capillare* var. *gattingeri* Nash in Britt. & Brown, Illustr. Fl. 1:123. 1896. *Panicum gattingeri* Nash in Small, Fl. s.e. U.S. 92. 1903. TYPE: U.S.A. TENNESSEE: cedar glades near Nashville, Sep, *A. Gattinger s.n.* (LECTOTYPE: fragment US! [designated by Hitchc. & Chase, Contr. U.S. Natl. Herb.]).

Panicum capillare var. *campestre* Gattinger, Tennessee fl. 94. 1887.

Panicum philadelphicum subsp. **lithophilum** (Swallen) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum lithophilum* Swallen, Proc. Biol. Soc. Wash. 54:43. 1941. TYPE: U.S.A. GEORGIA: on rocky slope, Stone Mountain, 23 Aug 1905, *A.S. Hitchcock and A. Chase 185* (HOLOTYPE: US 952898!).

Panicum rigidulum subsp. **abscissum** (Swallen) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum abscissum* Swallen, J. Wash. Acad. Sci. 30:215, f. 4. 1940. TYPE: U.S.A. FLORIDA: Sebring, in dry sand at tourist camp near lake, 3 Oct 1925, *P. Weatherwax s.n.* (HOLOTYPE: US 1259952!).

Panicum rigidulum subsp. **combsii** (Scribn. & C.R. Ball) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum combsii* Scribn. & C.R. Ball, U.S.D.A. Div. Agrost. Bull. 24:42, f. 16. 1901 [imprint date 1900]. *Panicum longifolium* var. *combsii* (Scribn. & C.R. Ball) Fernald, Rhodora 36:69 (1934). *Panicum rigidulum* var. *combsii* (Scribn. & C.R. Ball) Lelong, Brittonia 36:263. 1984. TYPE: U.S.A. FLORIDA. Washington Co.: damp fertile flat woods [low pine barrens] at Chipley, 20 Aug 1898, *R. Combs 583* (HOLOTYPE: US 80589!).

Panicum rigidulum subsp. **elongatum** (Pursh) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum elongatum* Pursh, Fl. Amer. Sept. 1:69. 1813 [imprint date 1814], *non* Salisb. (1796). *Panicum agrostoides* var. *elongatum* (Pursh) Scribn., Tennessee Agric. Exp. Sta. Bull. 7:42. 1894. *Panicum rigidulum* var. *elongatum* (Pursh) Lelong,

Brittonia 36:263. 1984. TYPE: U.S.A. DELAWARE: *F.T. Pursh s.n.* (LECTOTYPE: K, photo US! [designated by Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:104. 1910]).

Panicum stipitatum Nash in Scribn., U.S.D.A. Div. Agrost. Bull. 17 [rev. ed.]:56, f. 352. 1901.

Panicum rigidulum subsp. **pubescens** (Vasey) Freckmann & Lelong, comb. & stat. nov. BASIONYM: *Panicum anceps* var. *pubescens* Vasey, U.S.D.A. Div. Bot. Bull. 8:37. 1889. *Panicum longifolium* var. *pubescens* (Vasey) Fernald, Rhodora 36:69. 1934. *Panicum rigidulum* var. *pubescens* (Vasey) Lelong, Brittonia 36:263. 1984. TYPE: U.S.A. ALABAMA: Mobile Co.: Mobile, *C.T. Mohr s.n.* (LECTOTYPE: US 80530! [designated by Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:105. 1910]).

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A NEW SPECIES OF *SENECIO* (ASTERACEAE) FROM DURANGO, MEXICO

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ABSTRACT

Senecio sandersiana B.L. Turner, sp. nov., is described and illustrated from near El Salto, Durango, Mexico. It occurs in pine-oak woodlands at relatively high elevations (ca. 2720 m) and is said to be common locally on shady slopes and along ledges. The species is believed to be closely related to *S. tolucannus* DC. but differs in leaf shape and features of the capitulescence.

RESUMEN

Se describe y se ilustra **Senecio sandersiana** B.L. Turner, sp. nov., de cerca de El Salto, Durango, México. Aparece en bosques de pino-encino en elevaciones relativamente altas (ca. 2720 m) y se dice que es común localmente en las laderas umbrías y a lo largo de cornisas. Se cree que la especie está emparentada con *S. tolucannus* DC. pero difiere en la forma de la hoja y características de la capitulescencia.

Routine identification of Mexican Asteraceae has revealed the follow novelty:

Senecio sandersiana B.L. Turner, sp. nov. (**Fig. 1**). TYPE: MEXICO. DURANGO: Mpio. El Salto, "rim of plateau W of La Ciudad, 3.1 km NW of Hwy 40 ... off Neveros rd. upper Arroyo Tascanto watershed," 2720 m, 19 Apr 1999, *A.C. Sanders et al. 22680* (HOLOTYPE: TEX!; ISOTYPE: UCR).

Similis *S. tolucanno* DC. sed laminas foliorum definite cordatis, petiolis angustioribus (2–4 mm vice 3–10 mm), et pedunculis elongatis cum solum 1 -2(–3) capitulis.

Perennial subscapose *herbs* to 60 cm high. *Leaves* glabrous or nearly so, 15–25 cm long, 3.0–8.5 cm wide, forming a persistent basal rosette; petioles of well-developed leaves alate, mostly 10–15 cm long, 2–4 mm wide; blades broadly ovate to cordate, the margins decidedly serrulate. *Heads* 1–3 at the apices of elongate nearly naked scapes (bearing 2–4 much-reduced, bract-like leaves). *Involucres* calyculate, the calyculae grading into the involucral bracts; inner bracts ca. 21 in a single series, ca. 8 mm long, 1.5 mm wide, sparsely glandular-pubescent along the margins, otherwise glabrous. *Receptacle* plane to concave, epaleate, glabrous, ca. 4 mm across. *Ray florets* 11–13, sterile; corollas yellow, glabrous; tubes ca. 6 mm long; ligules 4–6 nervate, 6–8 mm long, 2–3 mm wide. *Disk florets* 40–60, fertile; corollas yellow, glabrous, ca. 7 mm long, the tube ca. as long as the cylindrical throat, the lobes 5, deltoid, ca. 0.5 mm long. *Style branches* linear, truncate, minutely hispidulous apically. *Achenes* (immature) ca. 2.5 mm long, glabrous; pappus of numerous white bristles somewhat longer than the disk corollas.

This taxon is closely related to the widespread species, *S. tolucannus* of the

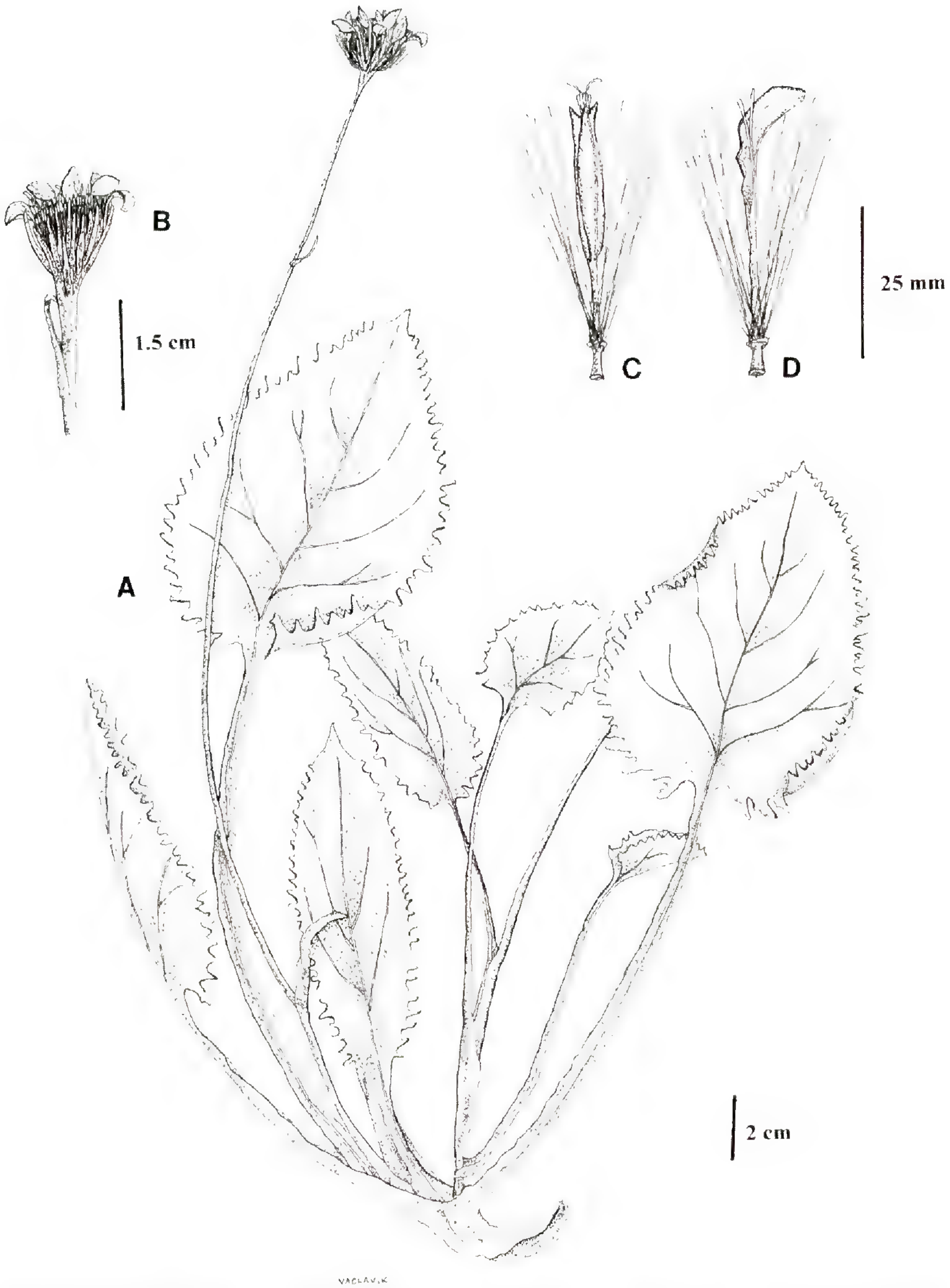


FIG. 1. *Senecio sandersiana*, from holotype.

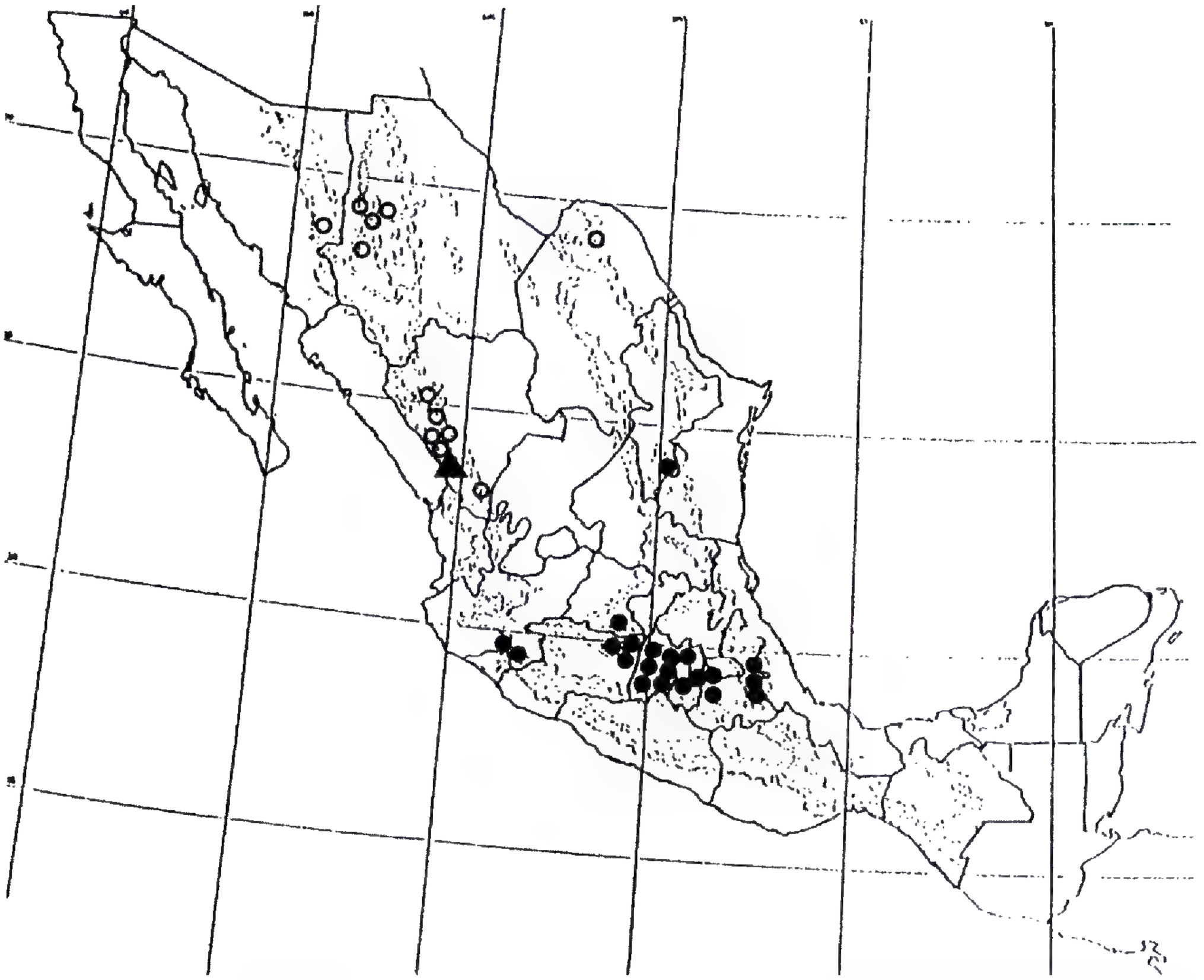


FIG. 2. Distribution in Mexico of *Senecio tolucannus* (closed circles), *S. wootonii* (open circles), and *S. sandersiana* (triangle).

Sec. Lugentes of *Senecio*. It might also be compared with *S. wootonii* Greene of the southwestern U.S.A. and closely adjacent northwestern Mexico. *Senecio sandersiana* differs from both in having fewer heads to a capitulescence and markedly cordate leaf blades. The distribution of these several taxa in Mexico is shown in Fig. 2.

Etymology.—The species is named for its primary collector, A.C. Sanders, Curator at UCR, an intrepid field worker. When informed of its possible novel status, he remarked via email:

"I knew that 22680 was something good when I found it and so I collected plenty. I'd never seen anything like it and was just very interested in the plant as an attractive object. This was the *Senecio* I was most interested in hearing about....I have 5 more sheets. It was very common where I found it: I had to walk through beds of it on the shaded slopes to find other things."

ACKNOWLEDGMENTS

I am grateful to my wife, Gayle Turner, for the Latin diagnosis. Susan Vaclavik provided the illustration.

BOOK REVIEWS

PAT HALLIDAY. 2001. **The Illustrated Rhododendron.** (ISBN 0-88192-510-1, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $69.95, 274 pp., 120 color illustrations, 4 line drawings, 8 1/4" × 11 3/4".

The author writes that, "this is primarily a book of 'pretty pictures.'" It is certainly a great deal more than that. The author, a staff member at Kew Gardens for more than 40 years, has culled from its archive an example of almost every subsection of every section of the genus Rhododendron. In a few cases, new plates were commissioned, or line drawings were prepared from herbarium material. Illustrations are arranged according to the author's classification system. The result is a comprehensive study with an updated text for each specimen and a discussion of the cultivation of rhododendrons.

Of particular interest is the fact that the original illustrations were taken from the pages of Curtis's Botanical Magazine, which has been in existence for 213 years and has published over 11,000 illustrations. There is a short essay on the history of the magazine, and because of the time spanned, the illustrations themselves provide a short history of botanical illustration.

This is a beautiful book which can be enjoyed by the rhododendron enthusiast, the admirer of botanical illustration, and the casual reader.—*Ruth Ginsburg, Fort Worth, Texas.*

NANCY KOBER. 2000. **With Paintbrush & Shovel.** (ISBN 0-8139-1969-X, hbk.). The University Press of Virginia. Charlottesville and London. (Orders: www.upress.virginia.edu). Price not given, 280 pp., 8 photographs, 1 map, 222 plates. 8 1/2" × 10".

In this story of the creation, between 1935 and 1940, of the Lee Park Wildflower and Bird Sanctuary in Petersburg, Virginia, the author has woven threads of many colors and textures into a fascinating tapestry. Under the auspices of the Works Progress Administration, thirty-three women, black and white, unemployed female heads of households, were hired to create a place where the natural heritage of the state would be preserved. This book is both a botanical and sociological study. There are sketches of the women who were involved, a description of the method of work and a discussion of the species and their habitat. There is a longer biography of the illustrator.

As the project developed, botanists recognized that some plants and habitats were already dis appearing. A herbarium was established to preserve a record of the region, and a watercolorist was commissioned to illustrate each species. Two hundred and twenty of these are reproduced in the book, arranged by habitat

This is an extremely interesting book on several levels and a tribute to the human spirit.—*Ruth Ginsburg, Fort Worth, Texas.*

TWO NEW SPECIES OF *WEINMANNIA* (CUNONIACEAE: CUNONIEAE) FROM SOUTHERN ECUADOR

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ABSTRACT

Two new species of Cunoniaceae, ***Weinmannia bradfordiana*** Z. Rogers and ***Weinmannia condorensis*** Z. Rogers are described and illustrated. Both sclerophyllous species are known only from their type localities and were collected from the Cordillera del Cóndor mountain range in the province of Morona Santiago, Ecuador.

KEY WORDS: Cunoniaceae, Cunonieae, Ecuador, Neotropics, South America, *Weinmannia*

RESUMEN

Se describe y se ilustra ***Weinmannia bradfordiana*** Z. Rogers y ***Weinmannia condorensis*** Z. Rogers. Estas dos especies esclerofilas son conocidas únicamente de las localidades de los tipos, y fueron colectadas en la región de la Cordillera del Cóndor en la provincia de Morona Santiago, Ecuador.

INTRODUCTION

The family Cunoniaceae is composed of 26 genera and about 300 species (Bradford & Barnes 2001). The australly-distributed genus *Weinmannia* L. accounts for about 150 species in five sections (Bradford 1998; Bradford 2002). All American species are in section *Weinmannia*, with the greatest species richness found in northwestern South America (i.e. Venezuela, Colombia, Ecuador and Peru) (Bernardi 1961; Harling 1999).

Weinmannia bradfordiana and *Weinmannia condorensis* were collected by the late Alwyn H. Gentry (1945–1993) on his last major expedition, and were filed in a "family indeterminate" folder for a number of years, despite the good quality of the specimens in flower and fruit. Later, while sorting Gentry's collections, Ron Liesner (MO) came across the specimens but did not initially consider the specimens as belonging to the family Cunoniaceae because of their uncharacteristically short inflorescences, but he did notice a few small fruits that looked remarkably like the septicidal capsules of *Weinmannia*. Ron then showed the material to Jason Bradford, who was studying Neotropical *Weinmannia* at the time, and Jason confirmed that they were, in fact, Cunoniaceae and annotated the specimens as new species of *Weinmannia* (Ron Liesner and Jason Bradford, pers. comm.).

Both species, as well as another recently described species of *Weinmannia*

from the Cóndor (Rogers 2002), have adapted extremely sclerophyllous habits due to the very wet and windy weather conditions and the very thin, nutrient-poor sandstone substrate. Many other woody genera on the summits of the Cordillera del Cóndor have similar sclerophyllous adaptations, and many of these species will also turn out to be new and locally endemic to the range.

Weinmannia bradfordiana and *Weinmannia condorensis* are known only from their types and are probably closely related, due to their similar leaf morphology and ecology and because they were collected from sites about 10 km apart, but significant differences exist between the two including: leaf size, leaflet shape, number of flowers per inflorescence, and trichome density and distribution on the stems, leaves, stipules and sepals. Based upon experience with other recognized species of *Weinmannia* and character variation within and among species, the differences observed from these specimens suggest they represent distinct species. This analysis is based entirely on a subjective study of the type collections and available herbarium specimens, so more collections will be needed to elucidate the patterns of variation in these species. At this time, the type localities are unable to be revisited because the sites have been covered by deadly land mines since the border dispute between Ecuador and Peru in January 1995, which was about 18 months after the types were originally collected. The mine field will not be cleared for at least several more years, but when the situation is resolved, further exploration will be needed and may expose intermediates that support a notion expressed by one reviewer (David Neill), who felt that both collections could represent a single species.

These new species can be easily distinguished from other Ecuadorian species by their small trifoliolate (rarely unifoliolate) compound leaves on short petioles that can appear to be simple and sessile to the naked eye, and by their extremely short inflorescences (i.e. pseudoracemes) due to inconspicuous peduncles. The highly reduced inflorescences are very uncharacteristic of the genus because almost all *Weinmannia* have elongated inflorescence axes measuring several cm or more in length.

Color images of the type collections can be found on the W3 TROPICOS database at: <http://mobot.mobot.org/W3T/Search/vast.html>.

Weinmannia bradfordiana Z. Rogers, sp. nov. (**Fig. 1**). TYPE: ECUADOR. MORONA SANTIAGO: Cantón Gualaquiza: Campamento Achupalla, Cordillera del Cóndor, 15 km E of Gualaquiza, tepui-like bromeliad sward with scattered, small trees, 03° 27'S, 78° 22'W, 2090 m, 21 Jul 1993 (fl., fr.), *Gentry 80312* (HOLOTYPE: QCNE-092179; ISOTYPES: AAU, GB-186976, MO-5544000, NY, US).

Haec species ad *Weinmanniam cochensem* Hieron. et *W. mariquitae* Szyszyl. maxime accedit, sed a hac inflorescentia subsessili, ab illa foliis multo minoribus ut videtur simplicibus sessilibusque propter petiolum perbrevem atque foliolis integris, ab ambabus foliis plerumque trifoliolatis interdum unifoliolatis distinguitur, a *W. condorensi* inflorescentia ex pseudoracemo fasciculis 2– ad 8 floris constante atque foliolis minoribus secus margines apicem versus trichomatibus plus quam 20 ciliatis distinguitur.

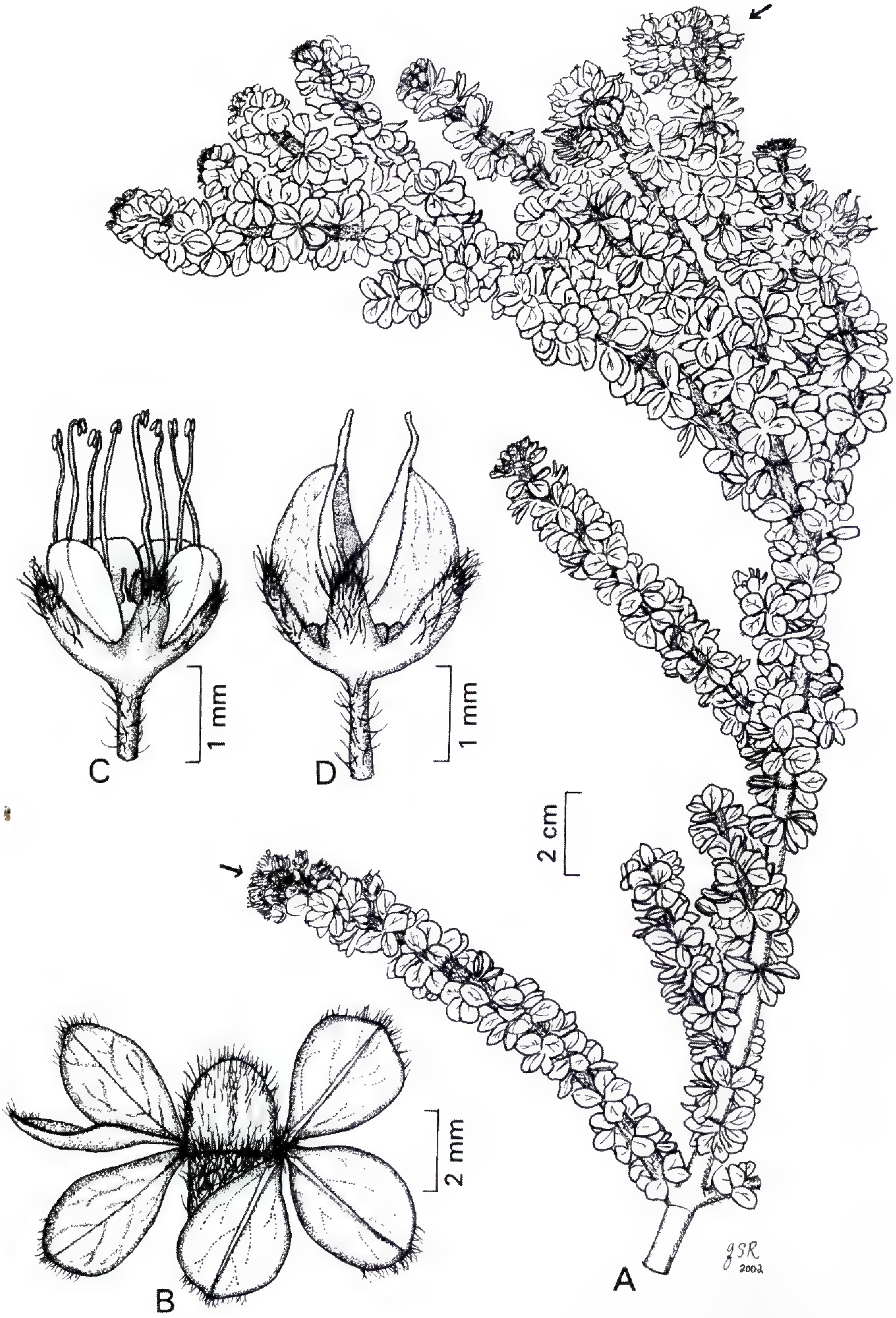


FIG. 1. *Weinmannia bradfordiana* Z. Rogers. A. Habit. B. Trifoliolate leaves showing the lower surfaces of the leaflets on the left side of the stem and the upper surfaces on the right. C. Flower. D. Septicidal capsule at maturity. Arrows point to inflorescences. All illustrations drawn by the author from the MO isotype (*Gentry 80312*).

Shrubs to 1 m; *young stems* covered with dense lanate or tomentose trichomes, the trichomes to 1.3 mm long, simple, unicellular, matted, stiff, white, nodes densely hirsute. *Leaves* to 5.3 mm long, opposite, compound, trifoliolate (rarely unifoliolate), densely congested; leaflets 2.0–4.9 × 1.4–3.3 mm, broadly obovate to nearly orbicular, broadly boat-shaped to nearly planar, upturned at apex, all leaflets similar in size and shape, coriaceous, thick, membranous and thin along the margins, shiny, drying dark brown on the upper surface and light brown on lower surface, midvein raised on upper and lower surface, thicker near the base, secondary veins 3–5 pairs per side, slightly raised to nearly inconspicuous on the upper surface, prominently raised on the lower surface, blade surfaces glabrous, usually lanate or tomentose along the upper one-third of the apical margins (usually more than 20 trichomes per apex), the trichomes are similar to those found on the young stems, 0.4–1.0 mm long, upper surface scrobiculate, lower surface scrobiculate and rugose, base cuneate to slightly oblique, margin entire, apex obtuse to slightly apiculate; petioles 0.1–0.4 mm long, reduced to inconspicuous or indiscernible protuberances, obscured by the dense pubescence at the nodes, dark red or black, densely hirsute or tomentose; petiolules 0.1–0.4 mm long, swollen, dark red or black, glabrous, rugulose; stipules 2.2–3.6 mm × 1.8–2.7 mm, interpetiolar, paired, free, broadly ovate to suborbicular, membranous to subcoriaceous, dark red or brown, outer surface densely lanate or tomentose, becoming more dense towards the apex and along the margin, trichomes to 1.1 mm long, similar to those found on the young stems, inner surface glabrous, base truncate, margin entire, apex rounded to obtuse, caducous. *Pseudoracemes* paired, unbranched, densely compacted, axillary on young growth at the terminus of the stem; peduncles to 0.9 mm long, reduced to inconspicuous protuberances, densely lanate or hirsute; fascicles (2–)4–8-flowered, densely compacted and congested; pedicels to 0.9 mm long in flower, to 1.9 mm long in fruit, sparsely lanate or hirsute; bracteoles not seen. *Flowers*, actinomorphic, bisexual, diplostemonous, recorded as white in color on the label; sepals 4, 1.0–1.2 × 0.5–0.9 mm in flower, to 1.4 mm long in fruit, ovate, subcoriaceous, adaxial surface glabrous, abaxial surface densely lanate to sparsely tomentose, denser near the apex and along the margin; petals 4, 1.0–1.2 × 0.8–1.0 mm, broadly elliptical to broadly obovate, membranous, white, midvein conspicuous, slightly raised and dark, glabrous, base truncate, margin entire and ciliated along the upper portion, apex rounded; stamens 8; filaments 0.8–2.0 mm long, 0.4–0.6 mm wide at base, flattened, slender at apex, glabrous; anthers 0.3–0.4 × 0.4–0.5 mm, orbicular, introrse, dorsifixed, longitudinally dehiscent; nectary disk annular with 8 concrescent lobes, surrounding the ovary, persistent in fruit; ovary 0.7–0.9 × 0.3–0.5 mm, superior, bicarpellate, syncarpous, red or brown, glabrous; styles 2, 0.2–0.4 mm long in flower, 0.6–0.9 mm long in fruit, divergent near the apex of the carpels, persistent in fruit; stigma simple, capitate. *Fruits* 1.9–2.4 × 1.4–1.8 mm (length measurement not includ-

ing the persistent styles), septicidal capsules, orbicular, occasionally widely ovate, dark red or brown, costate longitudinally, glabrous; seeds not seen.

Distribution and Habitat.—*Weinmannia bradfordiana* is known only from the type locality, collected near one of the summits of the Cordillera del Cóndor at about 2100 m elevation, and located about 15 km SE of the town of Gualaquiza. The Cóndor mountain range is covered by "dwarf-forest" vegetation consisting of many species of shrubs and small trees that have evidently adapted sclerophyllous habits due to thin, nutrient-poor sandstone substrate, and extremely wet and windy weather on the ridge.

Etymology.—The epithet was chosen in honor of Dr. Jason C. Bradford, who has spent a number of years in the field collecting Cunoniaceae, and who has made valuable contributions to our knowledge of the family through his continuing research efforts.

Weinmannia condorensis Z. Rogers, sp. nov. (**Fig. 2**). TYPE: ECUADOR. MORONA SANTIAGO: Cantón Gualaquiza: Crest of Cordillera del Cóndor, ridge top 15 km ENE of Gualaquiza, high montane forest and bromeliad sward. 03°22'S, 78°20'W, 2500 m, 26 Jul 1993 (fl., fr.), *Gentry 80465* (HOLOTYPE: QCNE-092303; ISOTYPES: AAU, MO-5613306, NY).

Haec species ad *Weinmanniam cochensem* Hieron. et *W. mariquitae* Szyszyl. maxime accedit, sed a hac inflorescentia subsessili, ab illa foliis multo minoribus ut videtur simplicibus sessilibusque propter petiolum perbrevem atque foliolis integris, ab ambabus foliis plerumque trifoliolatis interdum unifoliolatis distinguitur; a *W. bradfordiana* inflorescentia ex pseudoracemo fasciculis 1- ad 2-floris atque foliolis majoribus secus margines apicem versus glabris vel trichomatibus 5 vel minus ciliatis distinguitur.

Trees to 3 m; *young stems* covered with dense lanate or hirsute trichomes, the trichomes to 1.1 mm long, simple, unicellular, matted, stiff, white, nodes densely hirsute. *Leaves* to 7.6 mm long, opposite, compound, trifoliolate (rarely unifoliolate), congested; leaflets 3.6–6.8 × 1.9–4.5 mm, obovate to elliptical, broadly boat-shaped to nearly planar, upturned at apex, all leaflets similar in size and shape, coriaceous, thick, membranous and thin along the margins, drying dark brown, shiny, midvein prominently raised on upper and lower surface, thicker near the base, darker than blade, secondary veins 2–5 pairs per side, raised to nearly inconspicuous on the upper surface, more prominently raised on the lower surface, blade surfaces glabrous, infrequently having a few sparse trichomes at the apical margins (usually 5 or fewer trichomes per apex when pubescent), the trichomes are similar to those found on the young stems, 0.1–0.4 mm long, upper and lower surface scrobiculate and rugose, base cuneate to slightly oblique, margin entire, apex obtuse to slightly apiculate; petioles 0.7–1.2 mm long, often inconspicuous, obscured by the dense pubescence at the nodes, dark red or black, sparsely hirsute or tomentose; petiolules 0.3–0.6 mm long, swollen, dark red or black, glabrous, rugulose; stipules 2.2–3.5 mm × 2.0–3.0 mm, interpetiolar, paired, free, ovate to suborbicular, membranous to sub-

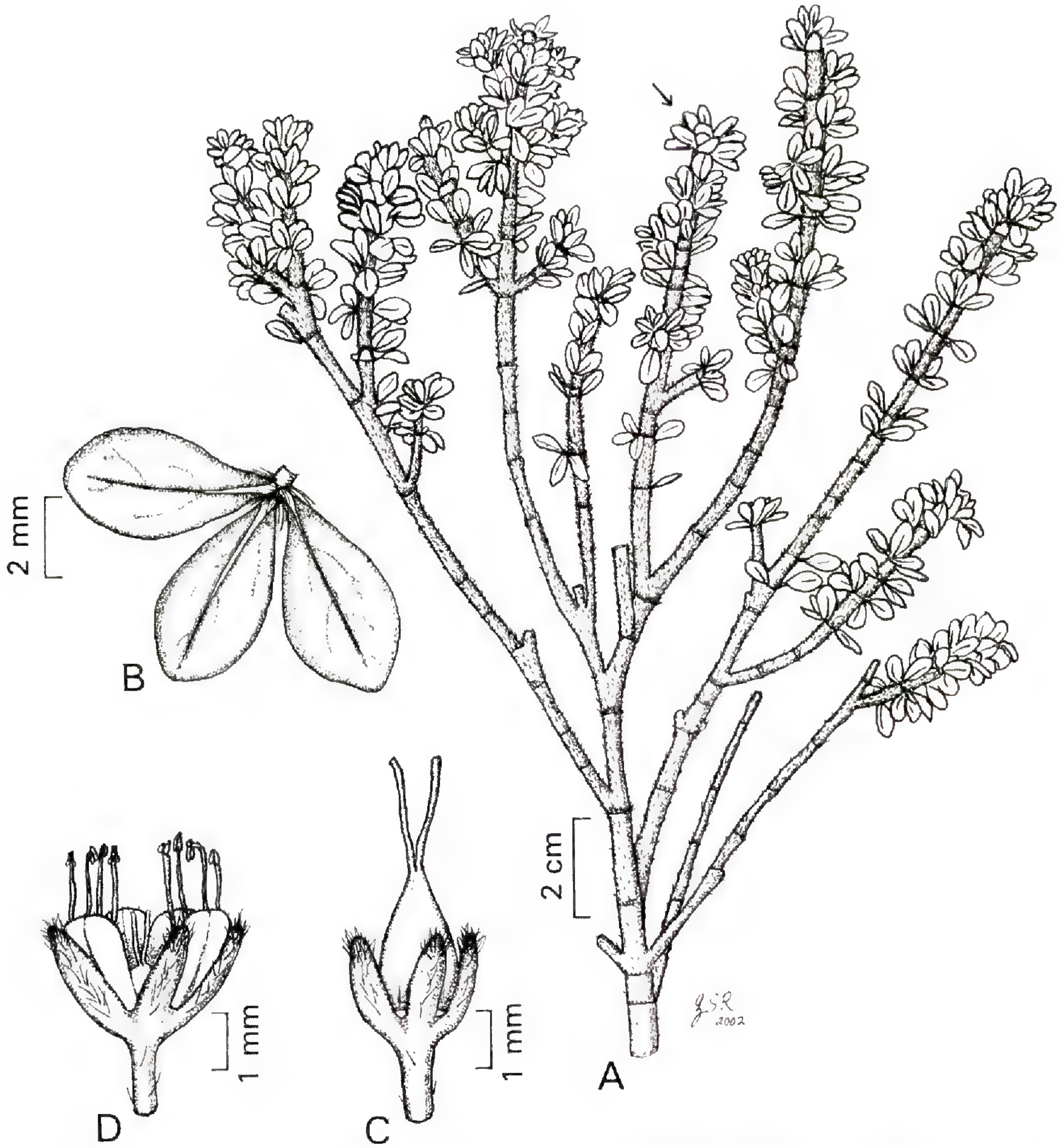


FIG. 2. *Weinmannia condorensis* Z. Rogers. A. Habit. B. Trifoliolate leaf. C. Immature capsule. D. Flower. The arrow points to the inflorescence. All illustrations drawn by the author from the type collection (*Gentry 80465*).

coriaceous, dark red or brown, outer surface glabrous to sparsely hirsute, densely hirsute along the margin, denser near the apex, trichomes 0.6–1.0 mm long, similar to those found on young stems, inner surface glabrous, base truncate, margin entire, apex rounded to obtuse, caducous. *Pseudoracemes* paired, unbranched, densely compacted, axillary on young growth, developing at 2 or more subsequent nodes at the terminus of the stem; peduncles to 0.4 mm long, reduced to inconspicuous protuberances in the leaf axils, lanate or hirsute, the trichomes are similar to those found on the young stems; fascicles 1- or 2-flowered, compacted and congested; pedicels to 1.2 mm in flower, sparsely hirsute; bracteoles not seen. *Flowers* actinomorphic, bisexual, diplostemonous, recorded as white

in color on the label; sepals 4, 1.6–2.4 × 0.8–2.0 mm, broadly ovate, subcoriaceous, adaxial surface glabrous, abaxial surface lanate, denser near the apex and along the midvein; petals 4, 1.6–2.0 × 1.2–2.2 mm, broadly elliptical to broadly obovate, membranous, white, midvein conspicuous, slightly raised and dark, glabrous, base truncate, margin entire and ciliated, apex rounded; stamens 8; filaments 0.8–2.5 mm long, 0.3–0.5 mm wide at base, flattened, slender at apex, glabrous; anthers 0.3–0.4 × 0.2–0.4 mm, orbicular, introrse, dorsifixed, longitudinally dehiscent; nectary disks annular with 8 concrescent lobes, surrounding the ovary, persistent in fruit; ovary to 0.9 mm long, to 0.6 mm wide, superior, bicarpellate, syncarpous, red or brown, glabrous; styles 2, to 2.1 mm long, divergent near the apex of the carpels, persistent in fruit; stigma simple, capitate. Fruits (immature) 1.8–2.5 mm long (measurement not including the persistent styles), septicidal capsules, ovate, dark red or brown, glabrous; seeds not seen.

Distribution and Habitat.—*Weinmannia condorensis* is known only from the type locality, collected on a ridge-top of the Cordillera del Cóndor mountain range at about 2500 m elevation, and located about 15 km ENE of the town of Gualaquiza. The site, as in the case of *W. bradfordiana*, is covered by "dwarf-forest" vegetation consisting of many species of shrubs and small trees with similar sclerophyllous adaptations.

Etymology.—The specific epithet refers to locality of the type collection.

Affinities.—According to the key for the Cunoniaceae in the Flora of Ecuador (Harling 1999), *W. bradfordiana* and *W. condorensis* would fit between the couplet *W. cochensis* Hieron. and *W. mariquitae* Szyszyl. because they have small compound leaves measuring less than 5 cm in length, but *W. mariquitae* is very different morphologically because it has much larger leaves with 4–8 leaflet pairs per leaf. On the other hand, *W. bradfordiana* and *W. condorensis* can be easily distinguished from the most morphologically similar species from Ecuador, *W. cochensis*, because they have smaller, trifoliolate (rarely unifoliolate) leaves with smaller, entire-margined leaflets, and inconspicuous peduncles. No other currently described species of *Weinmannia* in Ecuador has such highly reduced compound leaves and peduncles.

Weinmannia bradfordiana can be vegetatively distinguished from *W. condorensis* by its smaller leaves, its smaller, more broadly obovate to suborbicular leaflets, by the presence of 20 or more trichomes found along the apical margins of most leaflets, and by its densely pubescent stipules. The inflorescences of *W. bradfordiana* are more congested by more numerous flowers, and have slightly longer, more globular peduncles than *W. condorensis*. In contrast, most leaflets of *W. condorensis* are typically larger, narrowly obovate to elliptical and glabrous. *Weinmannia condorensis* also has inflorescences that are reduced to only 1 or 2 flowers, and stipules that are mostly glabrous except for a dense apical pubescence.

Another novel and distinctive character separating the two species is that *W. condorensis* has a rare inflorescence architecture, where pairs of racemes develop at two successive nodes near the terminal end of the main stem. The inflorescence of section *Weinmannia* (i.e. all Neotropical species) is limited to a pair of racemes developing from axillary buds at the most distal node, and is a distinctive character of the section. The development of racemes at two subsequent nodes has not been found in other Neotropical members of the genus, but it has been observed in a small group of species from Madagascar and the Comores (Bradford, pers. comm.). Patterns in inflorescence architecture are relatively stable in *Weinmannia*, and in many cases, can be more helpful than plastic vegetative characters, which often prove to be similar among many closely related species (Bradford 1998). The interesting inflorescence architecture of *W. condorensis* will definitely warrant further investigation once more collections are made available.

KEY TO MORPHOLOGICALLY SIMILAR SPECIES OF *WEINMANNIA* IN ECUADOR

1. Leaves 10–20 mm long, margins crenate at apex, usually 3–5 teeth, rarely 0; petioles 2–4 mm long; peduncles to 15 mm long _____ **Weinmannia cochensis**
1. Leaves to 7.6 mm long, margins entire; petioles inconspicuous to 1.2 mm long; peduncles inconspicuous to 0.9 mm long.
   2. Leaflets broadly obovate, margins usually covered by a dense apical pubescence (20 or more trichomes); stipules densely pubescent throughout; inflorescences (2–)4–8-flowered, only developing at the most distal node of the terminal end of the main stems _____ **Weinmannia bradfordiana**
   2. Leaflets narrowly obovate to elliptical, margins usually glabrous, or rarely with about 5 or fewer trichomes at the apices; stipules pubescent, trichomes concentrated along the apices and along the midvein; inflorescences 1- or 2-flowered, developing at two or more successive nodes at the terminal end of the main stems _____ **Weinmannia condorensis**

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The author thanks Jason Bradford (MO-DAV), Richard Barnes (HO) and David Neill (MO-QCNE) for their helpful review suggestions on the manuscript. The author would also like to thank Ron Liesner (MO) and Jon Ricketson (MO) for their comments, Roy Gereau (MO) for his preparation of the Latin diagnoses, Barney Lipscomb (BRIT) for waving the publication costs of this manuscript, and Uno Eliasson (GB) for expeditiously providing loan material.

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BOOK REVIEWS

HOWARD GARRETT with ODENA BRANNAM. 2001. **Herbs for Texas.** (ISBN 0-292-78713-3, hbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (Orders: 800-252-3206, 800-687-6046 fax). $60.00, 280pp. 8 photographs, 1 map, 222 plates. 8 1/2" × 11".

In this fully illustrated, easy to use guide, expert advice is offered by Garrett and veteran herbalist Odena Brannam on growing nearly 150 herbs suited to Texas and Southwestern gardens. Included is detailed information on each plant's landscape, culinary, medicinal, and other uses.

Individual entries give each herb's common and scientific names and instructions for planting, growing, harvesting, and storing it. The entries also include ideas for using each herb in gardening and cooking, with occasional recipes, and discuss its medicinal uses. Unique is the special "insight" entries that offers intriguing and little-known facts about the herbs. Each herb has a color photo.—*Gary Jennings, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A.*

NANCY LEYS STEPAN. 2001. **Picturing Tropical Nature.** (ISBN 0-8014-3881-0, hbk.). Cornell Univ. Press, 512 East State St., Ithaca, NY 14850, U.S.A. (Orders: 607-277-2211, 607-277-6292 fax). $35.00, 243 pp., numerous b&w photos, 6" × 9 1/4".

"Tropical nature as jungle is an artifact of history and culture. .." This is essentially what historian Nancy Leys Stepan proves in a well-documented account of how the tropics have been depicted historically in descriptive writings, art, literature, and landscape design. The focus is on Brazil (the name of which comes from the name of a plant), beginning with the accounts, verbal and pictorial, of Humboldt, Bates, Darwin, and Wallace, who described the "radical otherness" of the jungles. The tropics were jungle, full of lush growth, of an infinite variety of plants and animals not yet described, of virgin lands for the explorer and scientist. The scenes were romantic if in reality arguments for colonization. With the arrival of European colonists, the infiltration of these lands by armies and their teams of medical doctors and closer association with the indigenous peoples, the perception was soon to change, especially as tropical diseases such as malaria and yellow fever took their toll. The jungle became "dark;" disease and death lurked everywhere.

A kind of racial science developed along with medical science. The native peoples were exploited photographically, in part by such investigators as Agassiz whose intent was to refute theories of evolution, and in part to show sexuality. Medical science was to prove that strange physiologies were abnormalities caused by disease. Indeed research and advances in microscopic photography aided in isolating the pathogens of diseases and identifying their vectors and resulted in an entirely different form of visual iconography. The story of Carlos Chagas, his resolving the mystery of the disease that bears his name, and his later failures is an engrossing one.

The work of Roberto Burle Marx, Brazilian botanist and landscape designer, is of special interest, as he embellished the cities of Sao Paulo and Rio with parks, gardens, and open spaces, bringing in native plants from the rain forest. (*Heliconia burle marxii* was one of his discoveries). His concepts were ecologically sound, visually impressive, and influential in concepts of landscaping..

In this work, Stepan offers much to the reader in social, cultural, and medical history. She also peruses the various contemporary concepts and philosophies of "nature" and "natural history." Not least are her notes included with extensive references, which are in themselves rewarding.—*Joann Karges, retired librarian, Texas Christian University, Fort Worth, TX.*

THE TAXONOMY AND MORPHOLOGY OF *MACRANTHERA FLAMMEA* (OROBANCHACEAE)

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ABSTRACT

Macranthera flammea (Bartr.) Pennell is a rare, biennial species endemic to the pine flatwoods of the lower coastal plain of the southeastern United States. Field, experimental garden, and herbarium studies were used to update the species description. The taxonomic history of the species is reviewed. Recognition of more than one taxon in the genus is not warranted because differences in calyx length and lobing are due to the placement of flower units within the architecture of the inflorescence on individual plants. A map of the species' range is provided.

RESUMEN

Macranthera flammea (Bartr.) Pennell es una especie rara, bienal endémica de los pinares de la llanura costera inferior del sudeste de los Estados Unidos. Se hicieron estudios de campo, jardín experimental, y herbario para poner al día la descripción de la especie. Se revisa la historia taxonómica de la especie. No se necesita reconocer más de un taxon en el género ya que las diferencias en la longitud del cáliz y lobulación se deben a la colocación de las unidades florales en la arquitectura de la inflorescencia en los distintos individuos. Se aporta un mapa del área de las especies.

INTRODUCTION

Macranthera is monotypic; the single species *M. flammea* is endemic to the southeastern coastal plain of the United States and is commonly referred to as "flame flower" or "hummingbird flower." It is listed as endangered by the state of Florida (Coile 2000). The genus was formerly placed in the Scrophulariaceae, but recent studies have shown that family to be a heterogenous group (Olmstead et al. 2001); the hemiparasitic taxa are better placed in the Orobanchaceae.

Here, an updated species description and range map are provided. More detail on the life history and pollination biology is documented by Alford (2000).

NOMENCLATURAL HISTORY

The many names that have been proposed for this species indicate the difficulty that early botanists had in understanding the taxon and its generic placement (Table 1). William Bartram (1791) first described *M. flammea* as *Gerardia flammea* during his travels through the southeastern states during 1773–1777.

In 1834, after examining an unlabeled specimen in the herbarium of the Academy of Natural Sciences, Philadelphia (PH), Nuttall published the genus

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TABLE 1. Synonyms for *Macranthera flammea*.

Synonym	Year
Gerardia flammea W. Bartram	1791
Conradia fuchsioides Nutt.	1834
Macranthera fuchsioides (Nutt.) Benth.	1836
Macranthera lecontei Torr.	1837
Russelia flammea (Bartr.) Raf.	1837
Flamaria coccinea Raf.	1837
Toxopus gymnanthes Raf.	1837
Toxopus calycinus Raf.	1837
Tomilix bracteata Raf.	1837
Dasystoma tubulosa Bertol.	1853
Macranthera fuchsioides var. *lecontei* (Torr.) Chapman	1860
Conradia lecontei (Torr.) Kuntze	1891
Macranthera flammea (Bartr.) Pennell	1913

Conradia as a dedication to the late Solomon W. Conrad, a Professor of Botany at the University of Pennsylvania. Nuttall proposed the name *Conradia fuchsioides*, because "the corolla and long exerted stamens put one in mind of some gigantic *Fuchsia*" (Nuttall 1834).

Bentham (1835) applied the name *Macranthera fuchsioides* (Nutt.) Benth., because *Conradia* had been previously applied to a genus of Gesneriaceae by Martius. The name *Macranthera* means "long anther." Bentham and LeConte were both originally cited as authors for the genus (Hooker 1835), although Bentham (1835) felt that Torrey alone should receive credit for the generic name.

Torrey (1837) described a second species, *M. lecontei* (sometimes spelled *lecontii*), from a specimen collected in Georgia in 1831 by LeConte. He believed it was distinct because the segments of the calyx were entire, linear-lanceolate, and approximately one-third the length of the corolla. In *M. fuchsioides* the segments of the calyx are dentately lobed and often as long as the corolla tube [on LeConte's specimen (NY), Torrey applied the name Conradia *lecontei* Torr., along with a note stating the segments of the calyx are entire]. The specimen itself is damaged, but an attached illustration depicts the entire sepals. Torrey actually published the species (1837) not as *C. lecontei*, but as *M. lecontei*, since Bentham (1835) had determined that *Conradia* was already in use.

Pennell (1935) questioned the authenticity of the collection site of *M. lecontei*, which was purportedly along the Altamaha River in Liberty County, Georgia, because that site was far removed from other known occurrences of the species. However, the species has been observed along the Altamaha River as recently as 1997 (M. Hopkins, pers. comm.).

Rafinesque (1837) proposed many new names for *Macranthera* (see Table 1).

Macranthera flammea Raf. was proposed on the basis of Bartram's original description.

However, Rafinesque thought the genus name *Macranthera* was inappropriate because he did not believe the anthers to be of considerable length, and he suggested the name *Toxopus*, meaning "incurved peduncles." He substituted *Toxopus gymnanthes* Raf. for *M. lecontei* Torr. and *Toxopus calycinus* Raf. for *M. fuchsioides* (Nutt.) Benth. He further proposed the genus *Tomilix* meaning "cut calyx" for *M. fuchsioides*, suggesting that this species be treated as either a subgenus or new genus because of the condition of the calyx and the presence of what he felt to be a bifid style. He proposed the binomial *Tomilix bracteata* Raf. as an additional name for *M. fuchsioides* (Nutt.) Benth. The new genus *Flamaria*, as in *Flamaria coccinea* Raf., was also proposed

Bertoloni (1853) described a new genus and species, *Dasystoma tubulosa*, after examination of collections in GH, NY, and PH. Chapman (1860) treated *M. lecontei* as a variety of *M. fuchsioides*, and Kuntze (1891) resurrected the genus *Conradia* on the basis of the type specimen that Torrey had originally identified as *C. lecontei*.

Pennell (1913) combined the two species of *Macranthera* into one, writing: "this difference [in the calyx] is due wholly to age of the flower, as may be readily seen in the field; young flowers are as in *lecontei*, while with age the sepals continue growing and become lobed while the corolla shrivels and shortens in situ, so bringing about the *fuchsioides* state." Pennell suggested that, because Bartram originally described the species, the accepted name must become *Macranthera flammea* (Bartr.) Pennell. He argued that Bartram named his species for its "flame-coloured" flowers which is a fitting description. *Gerardia* was rejected as a generic name because it is a synonym for *Agalinis*.

Later, many were concerned about the validity of Bartram's binomials (Fernald 1944; Rickett 1944; Merrill 1945). Rickett (1944) argued that Bartram's binomials are inappropriate because they appear in a publication that is not always consistent with the Linnean system of binomial nomenclature. Merrill (1945) defended Bartram's binomials, writing: "the proportion of binomials to polynomials, 358 to 2, is too great in favor of the former to justify the elimination of Bartram's work." Wilbur (1971) argued that, if a Bartram binomial is accompanied by an adequate description, the publication of the binomial should be considered valid.

Additional controversy surrounds Bartram's description of his collection site. He probably confused the locality of his specimen of *Macranthera* with that of the mint *Calamintha coccinea* (Nutt.) Benth. While traveling along the Tensaw River near "Taensa" (near or in Baldwin Co, Alabama), Bartram (1791) recounts the following observations: "These stony gravelly heights produce a variety of herbaceous plants, but one in particular I shall mention on account

of its singular beauty. I believe it is a species of *Gerardia* (*Gerardia flammea*); it grows erect, a single stem from a root, three or four feet in height, branching very regularly from about one half its length upwards, forming a cone or pyramid, profusely garnished with large tubular labiated scarlet or flame coloured flowers, which give the plant a very splendid appearance even at a great distance." This description closely describes, for the most part, the form and appearance of *M. flammea*, but the locale and scarlet flower color are more appropriate for the mint *Calamintha coccinea* (Merrill 1945). Unlabeled specimens of both plants were found in Bartam's collection at the Natural History Museum in London (Pennell 1935). Bartram's description is applicable in part to both plants (Table 2), but Pennell (1935) believed Bartram's description to be most applicable to *M. flammea*.

SPECIES DESCRIPTION

Macranthera flammea is generally an herbaceous biennial of the Orobanchaceae Rosette leaves on juvenile plants are oblanceolate to spatulate. Leaves are glabrous with entire or pinnately lobed margins, depending on developmental stage. Rosettes are variable in leaf number and leaf size, having 3–46 leaves per rosette with lengths of 3–33 cm and widths of 0.8–3.6 cm (Fig. 1).

Plants may be more appropriately classified as monocarpic perennials because they may remain in the rosette phase for more than one year. Rosettes that have attained a critical size are triggered to reproductive states by an increase in day length. Before a rosette bolts into a flowering adult, it begins to produce pinnately lobed leaves.

Reproductive plants of *M. flammea* are mostly 15–30 dm tall, with stems that are obtusely four-angled and essentially nonbranching below the candelabralike spreading inflorescence. Cauline leaves are opposite and sessile or have short, winged petioles. Lower leaves are 8.5–16 cm long and 2–6 cm wide, lanceolate to ovate, and pinnately lobed. Leaves are progressively reduced upward along the stem; the uppermost are 4–7 cm long and 1–2.5 cm wide, slightly lobed, and toothed or entire. Blades are glabrous, or with minutely ciliate margins. Rosettee and lower leaves are usually shed by the time of anthesis.

The paniculate inflorescence contains long, indeterminate, racemose branches (Fig. 2). Flowers are axillary to a reduced, usually entire, foliar bract (see illustration in Godfrey and Wooten 1981). Pedicels are 1–2 cm long, becoming reflexed in fruit. The calyx is fused with five short lobes that are equal and linear and 7.5–15 mm long. The corolla is bright orange, fleshy, 2–2.5 cm long, short pubescent without, and glabrous or slightly pubescent at the base within. A whitish nectar chamber at the corolla base is 4 mm long.

The corolla turns brown to black with age. The tube is cylindrical and much longer (20–23 mm) than the two-lipped lobes (3–4.5 mm), with an adaxial lip

TABLE 2. Similarities of Bartram's description of *Macranthera* and *Calamintha*.

	Macranthera	*Calamintha*
Habitat	wet boggy thickets	*stony gravelly heights*
Plant branching	*regular, in upper half*	intricately, from base
Plant shape	*tall pyramidal cone*	low spreading
Plant height	3–8 feet	*3–4 feet*
Corolla shape	*tubular labiated*	*tubular labiated*
Corolla color	*flame colored*	*scarlet*

that is two-lobed and erect and a three-lobed, spreading abaxial lip. The four contiguous stamens are equal in length and exerted. The filaments are orange and become about twice as long as the corolla tube, up to 46 mm. The ovary is ovoid and has a slender style that is to 46 mm and a linear-clavate stigma. Mature bicarpellate capsules are 9.5–13 mm long, 7.5–10.5 mm wide, loculicidal, and slightly pubescent. The seeds are brownish black, 2.5–3 mm long, half as wide, irregular in shape (angular-lunate to triangular) with two or three fluted membranous wings. Specimens of *M. flammea* become black upon drying (due to presence of orobanchin or iridoid compounds as in related parasitic taxa).

The species description is verified by examination of collections (Appendix 1) from major and regional herbaria: Angus K. Gholson (personal collection designated AKG; it will eventually become part of FLAS), University of Florida (FLAS), Florida State University (FSU), Gray Herbarium (GH), University of Southern Mississippi (no official abbreviation, designated HATT here for convenience), Jacksonville State University (JSU), Louisiana State University (LSU), Missouri Botanical Garden (MO), New York Botanical Garden (NY), Old Dominion University (OD), Academy of Natural Sciences of Philadelphia (PH), Smithsonian Institution (US), University of Georgia (GA), University of Mississippi (MISS), University of South Alabama (USAM), Valdosta State University (VSC), and Vanderbilt University (VDB).

The species description is also supplemented by measurements taken from several plants at two field sites: Thomas Co., Georgia, at Greenwood or GWD (*Alford 1077* at FSU) and Liberty Co., Florida, in the Apalachicola National Forest or ANF (*Alford 1064* at FSU).

Range and Habitat.—The range of *M. flammea* (Fig. 3) extends along the lower coastal plain from Georgia to southeast Louisiana. This species requires mesic habitats of bogs and thickets and is ecotonal, occurring in the sandy acid soils of pine flatwoods along the margins of seepage slopes and shrub-tree bogs or bays (Small 1933). It can occasionally be found in shallow water of cypress-gum ponds or depressions (Godfrey & Wooten 1981). It does not tolerate standing water and can only be found in areas where water flow is sufficient (Determann et al. 1997).

Macranthera flammea

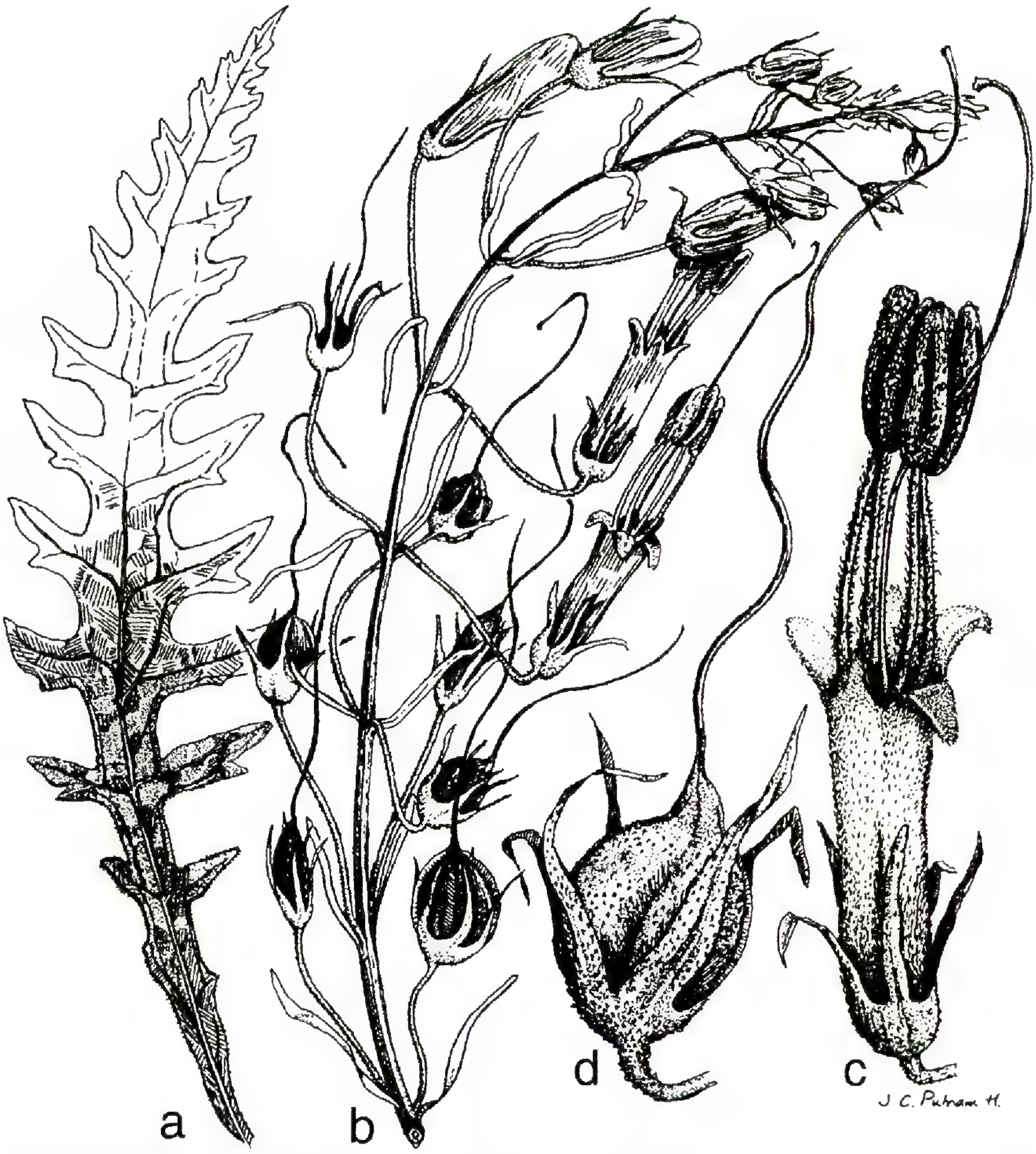


FIG. 1. *Macranthera flammea*. a, lower cauline leaf; b, branch of inflorescence; c, flower with exserted stamens and style; d, fruit with persistent style. Modified from drawing by Jean C. Putnam-Hancock in Chafin (2000); used by permission.

Woody plants associated with *M. flammea* include: *Acer rubrum* L., *Aronia arbutifolia* (L.) Ell., *Clethra alnifolia* var. *tomentosa* (Lam.) Michx., *Cliftonia monophylla* (Lam.) Britt. ex Sarg., *Cyrilla racemiflora* L., *Fraxinus caroliniana* Mill., *Ilex coriacea* (Pursh) Chapm., *Ilex glabra* (L.) Gray, *Itea virginica* L., *Liriodendron tulipifera* L., *Lyonia lucida* (Lam.) K. Koch, *Magnolia virginiana* L., *Myrica cerifera* L., *Nyssa sylvatica* var. *biflora* (Walt.) Sarg., *Persea palustris*

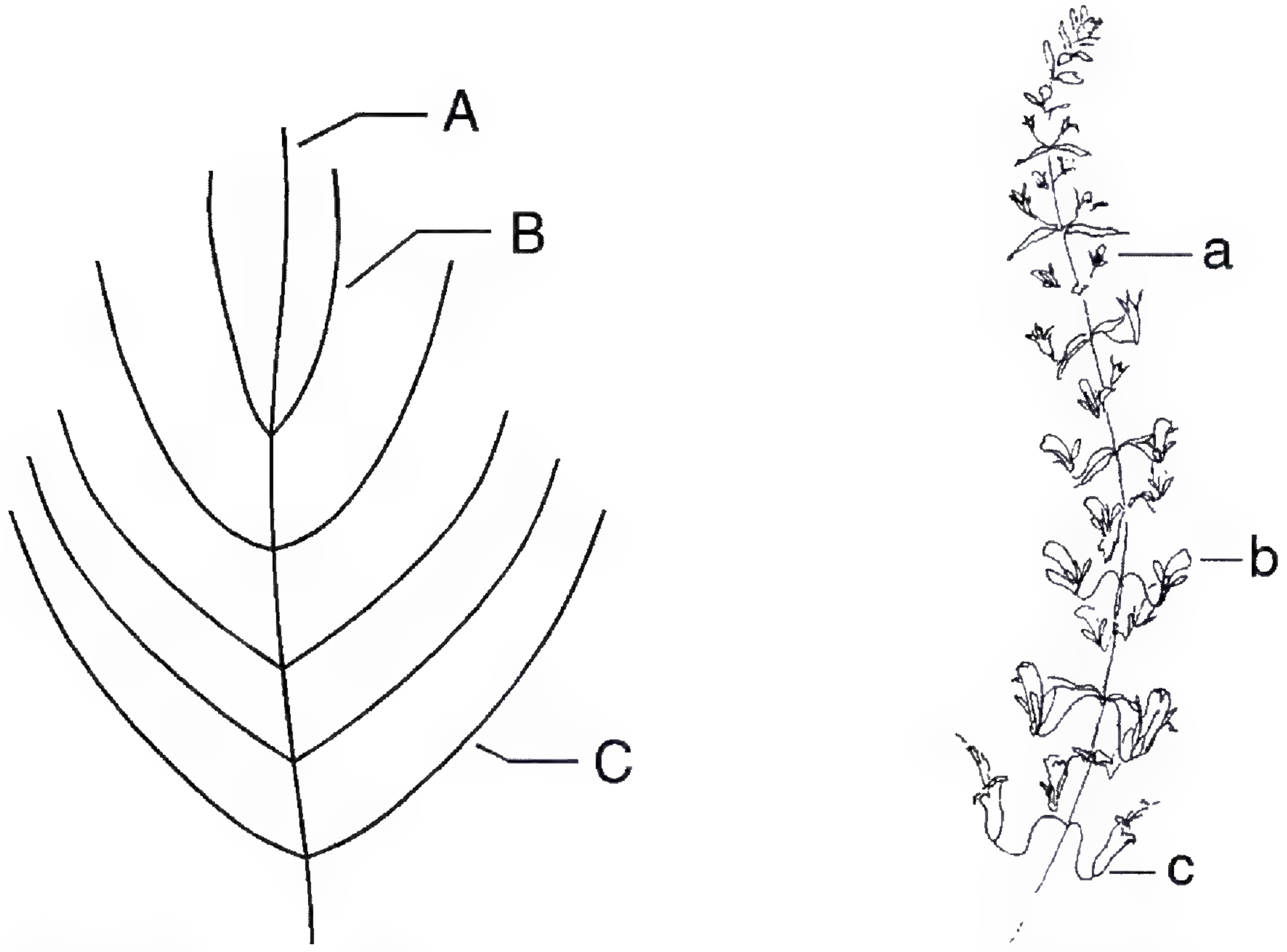


FIG. 2. Raceme and bud positions for study of morphological variability. A, terminal raceme of panicle; B, upper axillary raceme; C, lower axillary raceme; a, upper bud on branch; b, median bud; c, lower bud.

(Raf.) Sarg., *Pinus elliottii* Engelm., *Pinus palustris* Mill., *Pinus serotina* Michx., *Rhododendron viscosum* (L.) Torr., *Viburnum nudum* L. Herbaceous associated taxa include: *Andropogon virginicus* L., *Aristida stricta* Michx., *Arnoglossum sulcatum* (Fern.) H. Robins., *Arundinaria gigantea* (Walt.) Muhl., *Coreopsis gladiata* Walt., *Elephantopus nudatus* Gray, *Erianthus giganteus* (Walt.) Muhl., *Eryngium integrifolium* Walt., *Helianthus angustifolius* L., *Hypericum cistifolium* Lam., *Hypericum galioides* Lam., *Hypericum tetrapetalum* Lam., *Hyptis alata* (Raf.) Shinners, *Juncus validus* Coville, *Ludwigia hirtella* Raf., *Osmunda cinnamomea* L., *Panicum scoparium* Lam., and *Pteridium aquilinum* (L.) Kuhn.

Common Name.—This species is commonly referred to as flame flower or hummingbird flower. In at least one instance, it was referred to as Spanish princess (Pickens 1955). Flame flower is an appropriate name for *M. flammea*. It is representative of the specific epithet because of the flame-like appearance of the orange-yellow corolla (and the candelabra branching habit lends a flame shape to the inflorescence). Hummingbird flower is less desirable as is could be applied to any number of species that have red or orange tubular corollas.



FIG. 3. Documented range of *Macranthera flammea* in the southeastern United States.

EXAMINATION OF MORPHOLOGICAL VARIABILITY

Taxonomists base plant descriptions on the morphology of repeating modular units of construction, i.e. leaves, flowers, etc. because, although the number of units and size of the whole plant can vary greatly with age and environmental conditions, genetic control maintains consistent size and form of modular units (Harper 1977). Differences between species depend on the morphological form of repeating units. Variation in characters may exist across the range of a species, within a single population, and even within a single individual.

Macranthera inflorescences are indeterminate as defined by Harper (1977). Meristems continue to produce new flowers and leaves, and the position of an individual flower on the inflorescence reflects its age. By measuring changes in floral characters through time, we determined how each individual flower is affected by its location within the architecture of an individual plant and whether Pennell (1913) was correct in stating that the differences (in calyx

length and lobing) between the two species recognized at that time (*M. fuchsioides* and *M. lecontei*) were in fact attributable to age.

We examined herbarium specimens (Appendix 1) to determine the extent of variability of morphological characters across the species' range. Characters considered were calyx length, corolla tube length, corolla lobe length, corolla width, pedicel length, bract length, fruit length, and fruit width. Because it was not always possible to know which part of the plant was represented by the herbarium specimen, we standardized measurements by choosing floral buds at the stage of development just prior to the separation of the corolla lobes. Lengths and width of mature fruits and, when available, the length and width of the lower and uppermost (just below the inflorescence) stem leaves were measured.

To examine the extent of variability within a population and also within a single plant, we randomly selected five plants from the established study site at GWD in Thomas Co., Georgia, that represented the range of environmental conditions for the site. Three flower buds (upper, median, and lower) were marked on each of three racemes of the inflorescence (terminal, upper axillary, and lower axillary), for a total of nine measured buds per plant (Fig. 4). Characters previously mentioned were then measured on marked buds every four days for a period of one month. We measured fruit and foliage on 12 plants randomly selected from the population.

Means and standard deviations were calculated for all measured characters from herbarium specimens (Table 3). Means and standard deviations of floral characters from the GWD sample population were calculated from characters measured on 28 August 1997 in order to determine the amount of variability for characters within the plant architecture at a given time (Table 3).

The standard deviations of measured characters (Table 3) for herbarium specimens reveal that although the floral tissue components (corolla tube) of the flower show little variability, variability is higher in the chlorophyll containing components (calyx, pedicel, and bract). The GWD population exhibited more variability overall in corolla tube and calyx lengths than the herbarium specimens because smaller and larger buds were included.

Plant 59 of the GWD sample population was selected to illustrate growth changes over time in corolla tube length (Fig. 4) and calyx length (Fig. 5) for each bud position of the three racemes examined. For each raceme, the corolla tube expanded rapidly (Fig. 4). On the terminal and lower axillary racemes, the tubes expanded to 22–24 mm before anthesis. Those of the upper axillary raceme reached only 20–22 mm. Corolla tube width was between 4 and 5 mm for all flowers examined.

The calyces of the lower and median buds on the terminal raceme (Fig. 5, a) had nearly reached their limits of expansion at the initial measuring, but

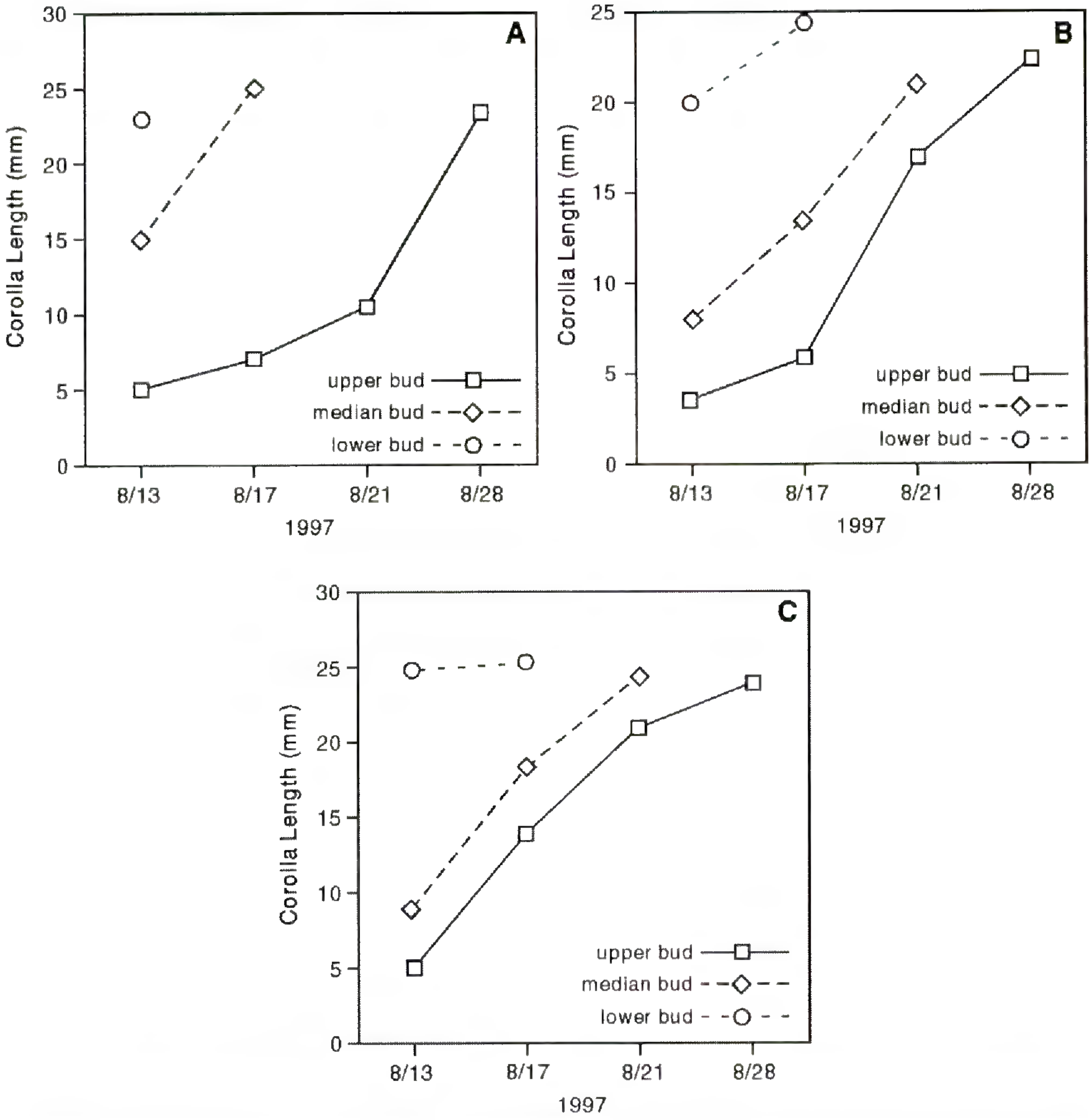


FIG. 4. Changes in corolla lengths from different positions on plant 59 at GWD during August 1997. A, terminal raceme; B, upper axillary raceme; C, lower axillary raceme.

calyx growth on the upper bud exhibited rapid elongation before reaching a plateau. Calyces of buds on the upper and lower axillary racemes (Fig. 5, b–c) also demonstrated rapid expansion before leveling off. The calyces of the upper buds were much shorter than those of the median and lower buds for all racemes examined.

Figure 6 illustrates calyx growth for the upper buds of the three racemes for three of the plants comprising the sample population. It shows that the upper axillary raceme had shorter calyces than did the lower axillary and terminal racemes for plants of the sample population.

Pedicels exhibited the same growth pattern as calyces. Bracts generally did not expand further once anthesis had occurred for an individual bud. Bracts

TABLE 3. Means and standard deviations for selected features of *Macranthera flammea*.

	Herbarium specimens			*GWD plants*		
Character	**x**	**s**	**N**	**x**	**s**	**N**
calyx length, mm	10.89	3.51	254	18.44	4.28	27
corolla tube length, mm	21.10	1.24	263	22.78	2.49	9
corolla lobe length, mm	3.86	0.81	240	---	---	–
corolla width, mm	4.71	0.78	194	4.11	0.43	9
fruit length, mm	11.22	1.81	102	10.61	0.64	12
fruit width, mm	9.0	1.41	102	8.7	0.52	12
pedicel length, mm	15.88	3.64	220	21.88	2.27	27
bract length, mm	21.38	14.31	133	32.15	9.47	27
upper leaf length, cm	5.59	1.53	93	9.59	1.47	12
upper leaf width, cm	1.8	0.9	93	3.19	0.77	12
lower leaf length, cm	12.5	3.81	28	19.72	2.03	12
lower leaf width, cm	4.21	2.26	28	4.03	0.41	12

did exhibit very rapid growth during bud expansion, and some of the bract lengths reached 50 mm for lower buds.

To produce more valid assessment of the amount of variation in calyx and corolla tube lengths observed in the GWD population (Table 3), we selected buds at various positions within the inflorescence and did not standardize to stage of development. The mean lengths of calyx, corolla, pedicel, and bract were greater in the GWD sample population because lower buds were included. Fruits measured in the GWD population tended to be shorter, narrower, and less variable than those in the herbarium specimens.

In general, variation was minimal in length and width of the corolla (Table 3, Fig. 4). Recent publications (Campbell et al. 1996; Smith et al. 1996; Temeles 1996) suggest that corolla width is the floral character selectively influenced by hummingbirds, a major pollinator of *M. flammea* (Pickens 1927).

The position of a flower within the framework of the inflorescence reflects its age (Harper 1977). Calyx length is determined by the position of a flower within the framework and is therefore determined by age of the flower. Observations (Figs. 5, 6) indicate calyces reach a plateau in their growth and do not continue to grow after flowering begins.

Pennell (1913) was correct in stating that the differences in the lengths of calyx lobes are due to the age of flowers. However, because lobes do not grow after anthesis, the position of the flower unit within the architecture of the inflorescence accounts for observed differences in calyx lengths. These growth characteristics are typical for plants with indeterminate inflorescences. Sepals, bracts, and pedicels are shorter for bud units at the tip of the raceme and longer for those near the bottom. Internodes at the tip of the raceme are truncated, those at the bottom elongated. Differences in the upper axillary branching po-

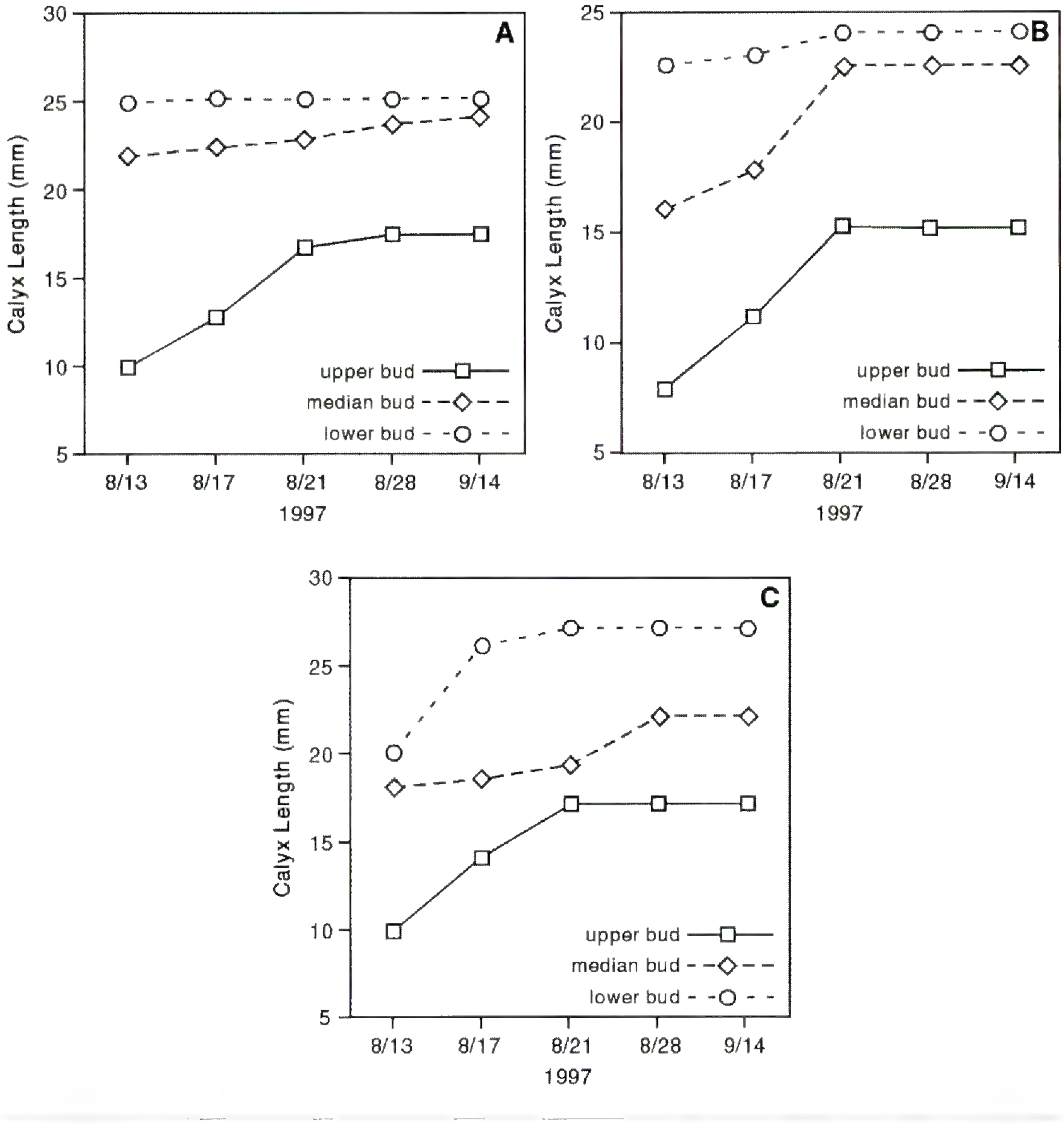


FIG. 5. Changes in calyx lengths from different positions on plant 59 at GWD during August 1997. A, terminal raceme; B, upper axillary raceme; C, lower axillary raceme.

sitions can be attributed to apical dominance. The terminal racemes are always the first to flower, followed closely by the lower axillary racemes. The racemes flower upwards on the inflorescence so that the upper axillary racemes are the last to reach anthesis (Fig. 2).

In general, as much variation appears to occur within a single plant or population as throughout the entire range. Observed variation in the characters of calyx, pedicel, and bract length can all be attributed to position effects within the architecture of the plant. Age determines the placement of individual flower units within an expanding inflorescence and therefore influences character morphology.

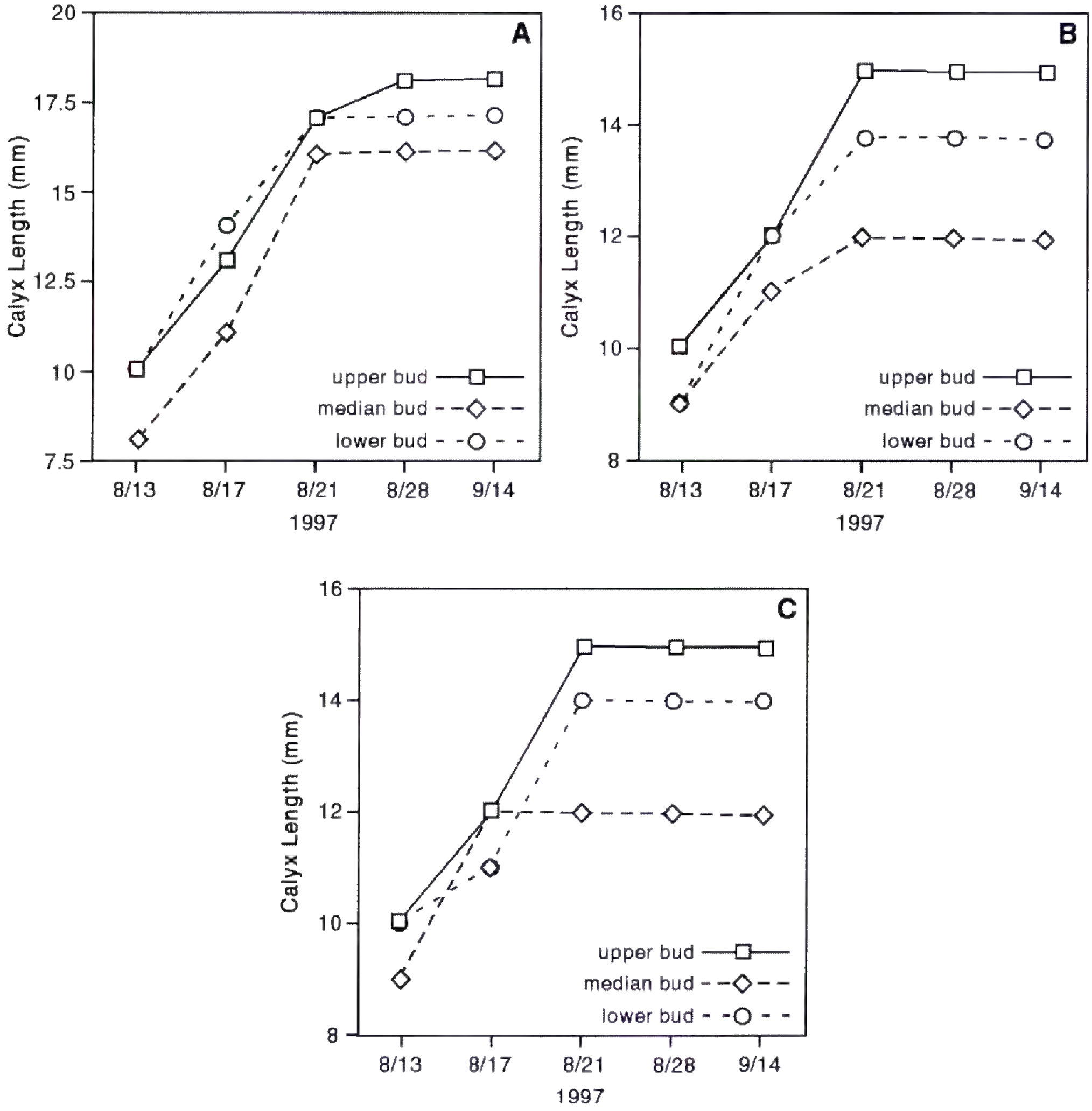


FIG. 6. Changes in calyx lengths from different positions on three separate plants at GWD during August 1997. A, terminal raceme; B, upper axillary raceme; C, lower axillary raceme.

Observations of herbarium specimens and the GWD population do not yield sufficient evidence of distinct variation in any character to warrant recognition of subspecific categories in *M. flammea*.

APPENDIX 1

Specimens examined and annotated documenting known range and morphological variability of *Macranthera flammea* (exact localities omitted because of species' rareness).

ALABAMA. Baldwin Co.: 7 Sep 1912, *F.W. Pennell 4553* (US, PH); 15 Oct 1940, *M.G. Henry 2445* (GA); 20 Aug 1947, *M.G. Henry 4935a* (PH); 23 Aug 1947, *M.G. Henry 4942* (PH); 16 Sep 1964, *S.M. McDaniel 5314* (FSU); 11 Sep 1979, *W.S. Judd 2288* (FLAS); 20 Aug 1981, *R. Kral 67854* (VDB). **Butler Co.:** 11 Oct

1970, *R. Kral 41623* (VDB). **Conecuh Co.:** 21 Aug 1981, *R. Kral 67829* (VDB); 18 Sep 1993, *R. Kral 83317* (VDB). **Covington Co.:** 3 Sep 1985, *S.A. Thompson 3011* (VSU). **Escambia Co.:** 21 Oct 1961, *R. Kral 38617* (VDB, NY); 17 Aug 1978, *R. Kral 32463* (VDB). **Geneva Co.:** 3 Sep 1969, *R. Kral 36844* (VDB). **Mobile Co.:** 1872, *D.C. Mohr* (NY); 1878, *D.C. Mohr* (US, NY); Aug 1892, *D.C. Mohr* (NY); 16 Sep 1892, *D.C. Mohr* (US); 30 Aug 1912, *F.W. Pennell 4406* (MO, US, PH); 31 Aug 1912, *F.W. Pennell 4459* (PH); 31 Aug 1912, *F.W. Pennell 4462* (PH); 4 Sep 1912, *F.W. Pennell 4534* (MO, NY, PH); Jul 1919, *E.W. Graves 1310* (MO); Aug 1919, *E.W. Graves* (US); 3 Sep 1966, *M.G. Lelong 4041* (USAM); 26 Aug 1969, *H.D. Moore 621* (VDB); 3 Sep 1972, *M.G. Lelong 6800* (USAM, VDB). **Washington Co.:** 21 Sep 1969, *R. Kral 37233* (FSU); 3 Sep 1970, *R. Kral 41062* (JSU, VDB); 9 Sep 1970, *H.D. Moore 1005* (VDB). **County unknown:** *Gates* (NY); *A. Gray* (GH); *J.H. Redfield* (MO).

FLORIDA. Bay Co.: 30 Oct 1957, *M.G. Henry 6753* (PH); 3 Sep 1958, *R.K. Godfrey 57619* (FSU). **Calhoun Co.:** 6 Sep 1964, *R.K. Godfrey 64605* (FSU); 18 Sep 1964, *S.M. McDaniel 5230* (FSU, VDB). **Escambia Co.:** 8 Aug 1955, *E.S.* Ford *4314* (FLAS); 21 Jul 1956, *P.L. Redfearn & R. Kral 2727* FSU); 9 Sep 1980, *J.R. Burkhalter* (FLAS); 11 Sep 1982, *J.R. Burkhalter 8470* (MO). **Franklin Co.:** 20 Sep 1912, *F.W. Pennell 4681* (GH, NY, PH); 22 Sep 1968, *A.K. Gholson 3133* (AKG); 7 Sep 1970, *A.K. Gholson* (AKG); 1 Sep 1976, *L. Conde* (FLAS); 12 Sep 1984, *L. C. Anderson 7573* (FSU); 11 Sep 1985, *L.C. Anderson 8798* (FSU). **Gadsden Co.:** Sep 1835, *Chapman* (NY, US); 1836, *Chapman* (GH); 10 Jan 1909, *Chapman* (GH); 30 Aug 1936, *H. Foster 120* (FLAS). **Holmes Co.:** 3 Sep 1942, *L.T. Nieland* (FLAS); 27 Aug 1947, *M.G. Henry 4967* (PH). **Jackson Co.:** 21 Aug 1971, *L.J. Musselmann & G.S. Waggonner 4393* (FSU, GH, NY, ODU, GA, VDB); 10 Oct 1978, *A.K. Gholson 7416* (AKG); 5 Oct 1979, *A.K. Gholson 8004* (AKG); 11 Sep 1983, *A.K. Gholson 10629* (AKG). **Leon Co.:** 17 Sep 1960, *H.L. Stripling 904* (FSU, 4 plants); 2 Jun 1970, *R.J. Nielsson* (FLAS). **Liberty Co.:** 3 Sep 1955, *R.F. Thorne & R.A. Davidson 16831* (FLAS, FSU, GA); 11 Sep 1974, *L.C. Anderson 3817* (FSU); 15 Sep 1979, *R.K. Godfrey 77250* (FSU); 15 Sep 1979, *A.K. Gholson 7985* (AKG); 7 Nov 1987, *P.W. Alcorn 378* (FLAS); 13 Sep 1989, *S.L. Orzell & E.L. Bridges 12054* (GA); 22 Oct 1993, *L.C. Anderson 14594* (FSU); 13 Sep 1997, *N. Jordan 16* (FSU); 27 Sep 1995, *J.D.* Alford *220* (FSU); 29 Sep 1997, *J.D.* Alford *1064* (FSU). **Okaloosa Co.:** 3 Oct 1949, *S.C. Hood 3214* (FLAS); 19 Oct 1971, *R.K. Godfrey 71005* (FSU); 2 Sep 1976, *A.K. Gholson 7985* (AKG); 2 Sep 1976, *R K. Godfrey 75446*(FSU); 16 Sep 1993, *L.C. Anderson 14558* (FSU). **Santa Rosa Co.:** 9 Sep 1912, *F.W. Pennell 4564* (MO, PH); 10 Sep 1912, *F.W. Pennell 4595* (GA, PH, US); 25 Aug 1957, *E.S. Ford 5403* (FLAS); 1 Nov 1969, *S.M. McDaniel 12519* (FSU, VDB); 2 Sep 1976, *R.K. Godfrey 75445* (FSU); 29 Sep 1990, *J.R. Burkhalter 23487* (FSU). **Walton Co.:** 2 Oct 1901, *A.H. Curtiss 6922* (GA, GH, MO, NY, US); 23 Sep 1956, *R.K. Godfrey & R. Kral 55157* (FSU, GA); 25 Aug 1966, *D.B. Ward 6006* (FLAS); 1 Oct 1970, *H.A. Davis 15418* (FLAS, GA, VDB); 6 Sep 1972, *E.H. Sargent & H.A. Davis 16029* (MO). **County unknown:** *Chapman* (NY); *Mohr* (NY).

GEORGIA. Bulloch Co.: *H. Hall* (GA). **Crisp Co.:** 4 Sep 1954, *W. H. Duncan 18189* (GA, VSC). **Early Co.:** 12 Aug 1947, *R.F. Thorne* (GH, US); 25 Aug 1948, *R.E. Thorne & W.C. Muenscher 8591* (GA). **Emmanuel Co.:** 2 Sep 1968, *J.R. Bozeman 11727* (FSU, GA, GH, HATT, MISS, MO, NY, ODU, VDB, VSC); 22 Aug 1983, *S.B. Jones 23813* (FSU, GA). **Thomas Co.:** 1897, *S.M. Tracy* (MO); 12 Sep 1998, *J.D. Alford 1077* (FSU). **Turner Co.:** 21 Sep 1975, *W.R. Faircloth 7893* (VSC). **Ware Co.:** 25 Aug 1946, *F.S. Sargent 122* (US). **Wilcox Co.:** 28 Aug 1964, *R. Kral 22278* (VDB). **Worth Co.:** 25 Aug 1947, *R.F. Thorne 6362* (NY). **County unknown:** *J.H. Redfield 12395* (MO)

LOUISIANA. St. Tammany Parish: 1846, *Chapman* (GH); 1846, *Drummond* (GH); 1909, *A. Gray* (GH); 11 Sep 1983, *C.M. Allen 12911* (LSU), 7 Sep 1985, *A.W Lievens 1003* (LSU); 7 Sep 1985, *L.E. Urbatsch* (LSU). **Washington Parish:** 27 Sep 1936, *C.A. Brown 6737* (LSU); 9 Sep 1962, *C.A. Brown 17584* (LSU); 31 Aug 1967, *L.J. Musselmann 1243* (MO); 28 Oct 1967, *J.W. Thieret 28304* (FSU, GH); 16 Aug 1970, *D. Ziegler* (MO); 13 Sep 1975, *R.D. Thomas 46210* (VDB); 22 Oct 1975, *Rich 209* (ODU); 20 Aug 1987, *N.M. Gilmore 3288* (LSU).

MISSISSIPPI. Forrest Co.: 14 Aug 1947, *M.G. Henry 4888* (PH); 7 Sep 1965, *J.W. Carter 941* (HATT); 3 Oct 1970, *K.E. Rogers 4679* (VDB); 15 Sep 1974, *J.W. Wooten 2519* (USM); 24 July 1976, *J.A. Barnes 648* (VDB). **George Co.:** 30 Sep 1995, *S.W. Leonard 9173* (FSU, 26 plants). **Hancock Co.:** 17 Aug 1969, *F.H.*

Sargent 9885 (MO, VDB); 16 Sep 1970, *S. B. Jones 20312* (FSU, GA, MISS, VDB); 16 Sep 1970, *F.H. Sargent 10390* (FSU); 28 Aug 1972, *H.L. Clark & K. Clark* (FSU, HATT); 29 Aug 1977, *M. Brooks* (FSU). **Harrison Co.:** 16 Sep 1885, *J.H. Redfield & J.D. Smith 16217* (GH, MO, NY, US); 18 July 1950, *G.L. Webster & R.L. Wilbur 3460* (GH, NY, US); 18 Aug 1950, *D. Demaree* (VDB); 16 Aug 1952, *D. Demaree 32853* (GH); 19 Aug 1971, *C.A. Brown 22040* (LSU, NY). **Jackson Co.:** 11 Sep 1889, *F.S. Earle* (NY); 16 Aug 1947, *M.G Henry 4921* (PH); 18 Aug 1949, *D. Demaree 28202* (NY); 20 Aug 1949, *D. Demaree 28300* (NY, VDB); 24 Aug 1951, *D. Demaree 31281* (VDB); 17 August 1952, *R.L. Diener 509* (MO); 24 Aug 1953, *R.B. Channell 343* (VDB); 11 Sep 1975, *M. Arguelles 1455* (VSC). **Lamar Co.:** 14 Aug 1927, *F. Cook* (US). **Layton Co.:** 15 Aug 1925, *F. Cook* (US). **Marion Co.:** 8 Aug 1955, *J.D. Ray* (GA, GH, NY); 5 Sep 1963, *R. Kral 19389* (VDB). **Pearl River Co.:** 19 Sep 1982, *S.M. McDaniel 26507* (FSU). **Perry Co.:** 15 Aug 1947, *M.G. Henry 4904* (PH); 4 Oct 1995, *S.W. Leonard 9181* (FSU, 28 plants). **Stone Co.:** 24 Aug 1953, *D. Demaree 34081* (GH, VDB); 8 Oct 1966, *T.M. Pullen 661140* (UM). **Winston Co.:** 6 Sep 1932, *F.H. Sargent* (NY). **County unknown:** 30 Aug 1941, *G.A. Girhart 87* (NY).

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THE GENUS *CAMPOMANESIA* (MYRTACEAE) IN ATLANTIC RAINFOREST FRAGMENTS IN SERGIPE, NORTHEAST REGION OF BRAZIL

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ABSTRACT

The Atlantic forest is one of the ecosystems of Brazil that has suffered the greatest destruction and it is still imperiled, especially in the Northeast. Sergipe is one of the states where the Atlantic forest has been most greatly reduced, but it still has some fragments varying in size and degree of conservation. Despite their importance, botanical studies within these fragments are still greatly needed. In this paper we report for the first time the occurrence of four species of *Campomanesia* in Sergipe: *C. aromatica*, *C. dichotoma*, *C. guaviroba*, and *C. viatoris*. The last, formally thought to be known from only two collections from Alagoas, has a relatively wide distribution in Sergipe, and is found in forest and restinga areas of different districts. *Campomanesia guaviroba* is reported for the first time from the Northeast of Brazil. We hope that studies on the composition of these remnants may contribute to the local preservation of this ecosystem and help future programs of forest restoration. We emphasize the need for a greater collecting effort, more studies on plant taxonomy, and the training of new specialists.

RESUMO

A mata atlântica é um dos ecossistemas brasileiros mais destruídos e ainda hoje ameaçado, sendo a sua devastação mais pronunciada no Nordeste do Brasil. Um dos estados com menor área de mata atlântica, Sergipe apresenta ainda hoje alguns fragmentos florestais com tamanho e grau de conservação variáveis. Apesar de sua importância, os estudos botânicos nesses fragmentos são ainda insuficientes. Nesse trabalho registra-se a ocorrência inédita de quatro espécies de *Campomanesia* em Sergipe: *C. aromatica*, *C. dichotoma*, *C. guaviroba* e *C. viatoris*. Esta última, anteriormente conhecida apenas por duas coletas, ambas em Alagoas, apresenta uma distribuição relativamente ampla no Estado, sendo encontrada em áreas de mata e restinga de diversos municípios. Registra-se, ainda, a ocorrência de *C. guaviroba* pela primeira vez na região Nordeste. Espera-se que estudos sobre a composição desses fragmentos possam contribuir para a preservação desse ecossistema a nível regional e subsidiar programas futuros de recomposição florestal. Salienta-se a necessidade de um esforço de coletas mais intenso, de mais estudos sistemáticos e da formação de novos especialistas.

KEY WORDS: *Campomanesia*, Myrtaceae, Sergipe, Atlantic rainforest fragments

INTRODUCTION

The objective of this note is to report the occurrence in Sergipe, Brazil of four species of *Campomanesia* Ruiz et Pavón (Myrtaceae), usually known locally as "guabirobas" or a variant of this name (e.g., guavirobas, gobiraba, gabiroba). None

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of these species, nor any other species of *Campomanesia*, was known for Sergipe when Landrum (1986) monographed the genus, and one species (*C. guaviroba*) has not been reported before in Brazil's Northeast region (Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, Bahia). The fact that recent floristic exploration can reveal so much is an indication of the importance of continuing efforts in this field.

Despite the great biological diversity of the Brazilian coastal forests, little of its original cover still persists. At the time of the European discovery such forest covered about 1,000,000 km^2 of Brazil, while today its area has been reduced to an estimated 5% (Consórcio Mata Atlântica 1992), 6% (Prance et al. 2000), or 8% (INPE and IBAMA 1990) of its original size. In spite of being protected by law, destruction of coastal forest still continues. The remaining areas consist of fragments varying in size and degree of conservation and are "typically small, isolated and highly disturbed" (Viana et al. 1997). Ranta et al. (1998) recently studied the degree of fragmentation in the Northeast Atlantic forest of Brazil, and emphasize the importance of fragment size and shape for the long-term survival of biodiversity. Smaller fragments and more irregularly shaped fragments have a higher proportion of their areas in edges, which are more vulnerable to plant extinction. Because fragmentation in Sergipe has progressed so far, extinction is more imminent.

The historical pattern of almost complete elimination of the native forest covering in Brazil's Northeast is explained by the relative gentle relief of the landscape and ease of access to all areas. Farther south, the mountainous terrain of the Serra do Mar makes access more difficult, and thus greater portions of Atlantic rainforests there are relatively protected. Sergipe, the smallest of the Brazilian states, originally had about 41% its area covered by forests (Campos 1912), but its forest covering today is estimated to be less than 1%. For this reason, Sergipe has been excluded in some mappings of the remnants of Atlantic forest carried out at the national level. However, floristic surveys in areas of Atlantic forest in the state (Landim et al. 1998) have shown it to be a forest with unique floristic and structural characteristics. Additional studies are urgently needed that contribute to knowledge of the forest's composition, structure and dynamics, with the aim being a knowledge base for reforestation initiatives.

The family Myrtaceae is mainly a tropical and subtropical family (Heywood 1993), with about 3500 species and approximately 100 genera, with two main centers of development: tropical America and Australasia (Barroso et al. 1991). It is a family of great importance in the neotropical forests, being one of the dominant families in Atlantic coastal forest (Barroso & Peron 1994; Leitão-Filho 1993; Mori et al. 1983; Peixoto & Gentry 1990; Reitz et al. 1978). In a study of Atlantic forest in São Paulo, Mantovani (1993) found 38 tree species of Myrtaceae (21% of the total). He considers Myrtaceae to be "the most character-

istic family of arboreal species of Atlantic forest in the south coast of the State of São Paulo, with floristic and structural importance."

In general, species of Myrtaceae are quite common in the Atlantic forest areas of the Northeast, (Siqueira 1994), and this has proved to be true the fragments studied in Sergipe. In a phytosociological study in the Mata do Crasto, in the Municipality of Santa Luzia do Itanhy (Landim et al. 1998), this family accounted for 10.3% of the sampled trees, and was the sixth in basal area, and fifth in importance value index (I.V.I.).

Voucher specimens of collections described below are deposited in the herbaria of the Department of Biology of the Federal University of Sergipe (ASE), the University of Brasília (UB), and Arizona State University (ASU).

RESULTS

Description of *Campomanesia*

Campomanesia can be distinguished from other genera of Myrtaceae by: **1)** ovary with (3–)4–18 locules (Fig. 1D); **2)** ovules several per locule, biseriate, all or all but one aborting in each locule; **3)** locule-wall in the mature fruit chartaceous to slightly woody, strongly glandular, serving as a false seed coat (Fig. 1C). In Sergipe, *Campomanesia* can be distinguished from most other genera of Myrtaceae when in flower by its 5-merous flowers and inflorescences of solitary flowers or dichasia. *Psidium* L. and *Calycolpus* O. Berg can be confused with *Campomanesia* in flowering specimens but generally have coriaceous leaves, whereas *Campomanesia* usually has submembranous to membranous leaves.

Campomanesia is quite distinctive in fruit. There seem to be several seeds in each fruit arranged in a ring, each with a glandular covering (Fig. 1D). However, each of these "seeds" is a locule, and usually only some of them have a seed inside. In others the ovules have all aborted. Other genera of Myrtaceae either have few seeds (e.g., 1 or 2 in *Myrcia*, *Eugenia*, or *Calyptranthes*) or the seeds are numerous and hard (e.g., *Psidium*, *Calycolpus*). In no other American genus of Myrtaceae do the seeds have a glandular covering.

The bark of the trunk of *Campomanesia* is usually rough with numerous narrow, papery plates, unlike most other genera that have smooth to scaly bark. The lateral veins of the leaves are generally prominent and broadly arch near the margin and the smaller veins often show an intricate reticulate pattern (Fig. 2).

KEY TO THE SPECIES OF *CAMPOMANESIA* IN SERGIPE

1. Calyx nearly closed in bud; inflorescence a dichasium with peduncle 2–6 cm long _____ **Campomanesia dichotoma**
1. Calyx open in bud; inflorescence uniflorous or a dichasium with peduncle up to 2 cm long.
   2. Hypanthium attenuate at base, constricted near apex; anthers 1–2 mm long _____ **Campomanesia viatoris**

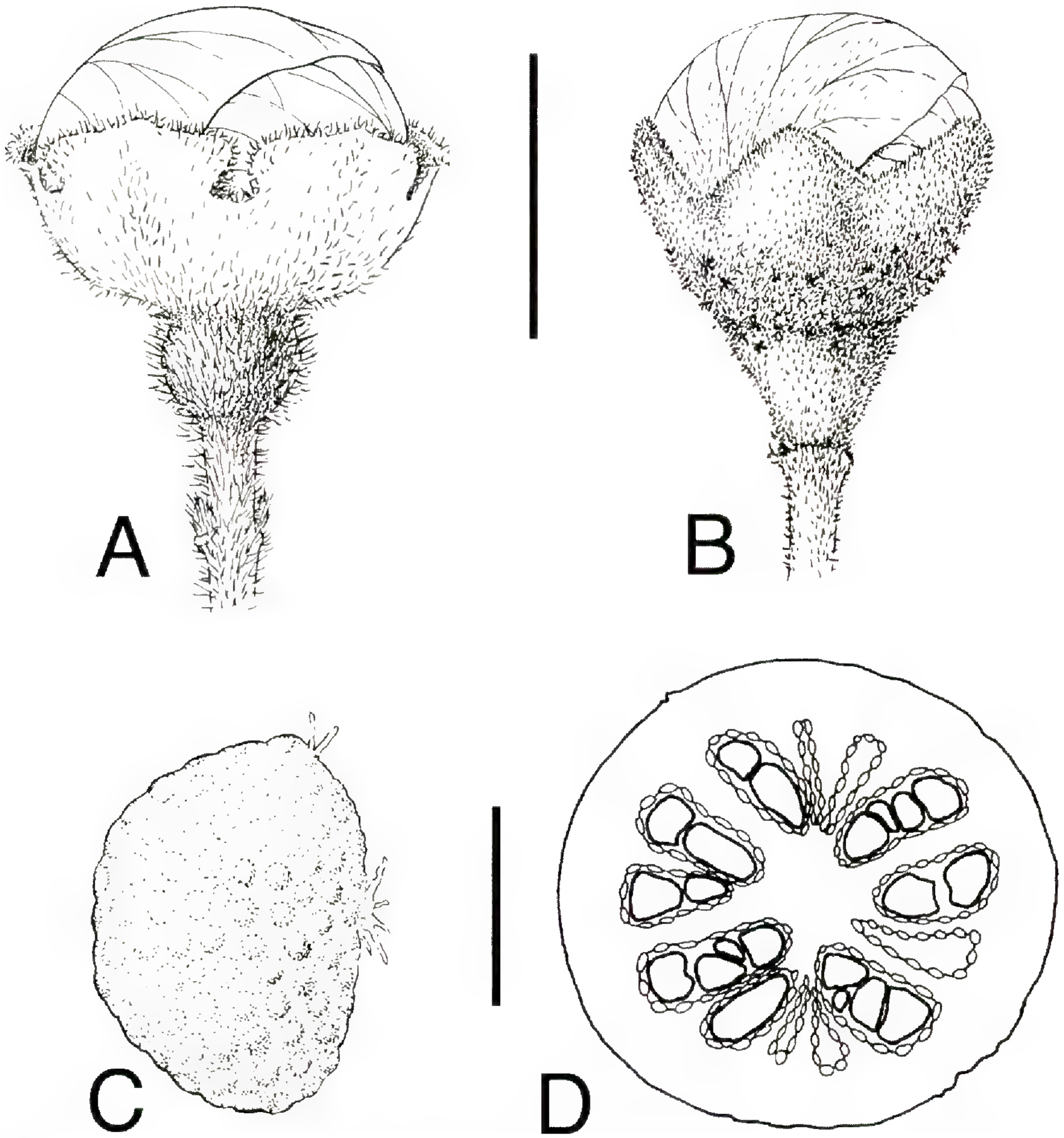


FIG. 1. A, Flower bud of *Campomanesia viatoris*. B, Flower bud of *C. guaviroba*. C, Locule containing a seed showing the glandular locular wall that serves as a false seed coat. D, Cross section of a fruit having 13 locules, each with a glandular wall, but only 8 of which contain seeds. Because the embryos are spiral in form, in section they may be cut in more than one place. Upper bar = 5 mm for A & B. Lower bar = 4 mm for C and 10 mm for D.

2. Hypanthium neither attenuate at base nor constricted near apex; anthers 0.5 1 mm long.
   3. Calyx-lobes hemiorbicular to oblong-truncate, 0.7–2.5 times as long as wide; leaves immature at anthesis; fruit black _____ **Campomanesia aromatica**
   3. Calyx-lobes broadly triangular or broadly rounded, 0.4–0.9 times as long as wide; leaves mature at anthesis; fruit yellow or orangish ____ **Campomanesia guaviroba**

Campomanesia aromatica (Aubl.) Grisebach

Shrub or tree 2–20 m high; leaves immature at anthesis, elliptic, ovate, lanceolate,

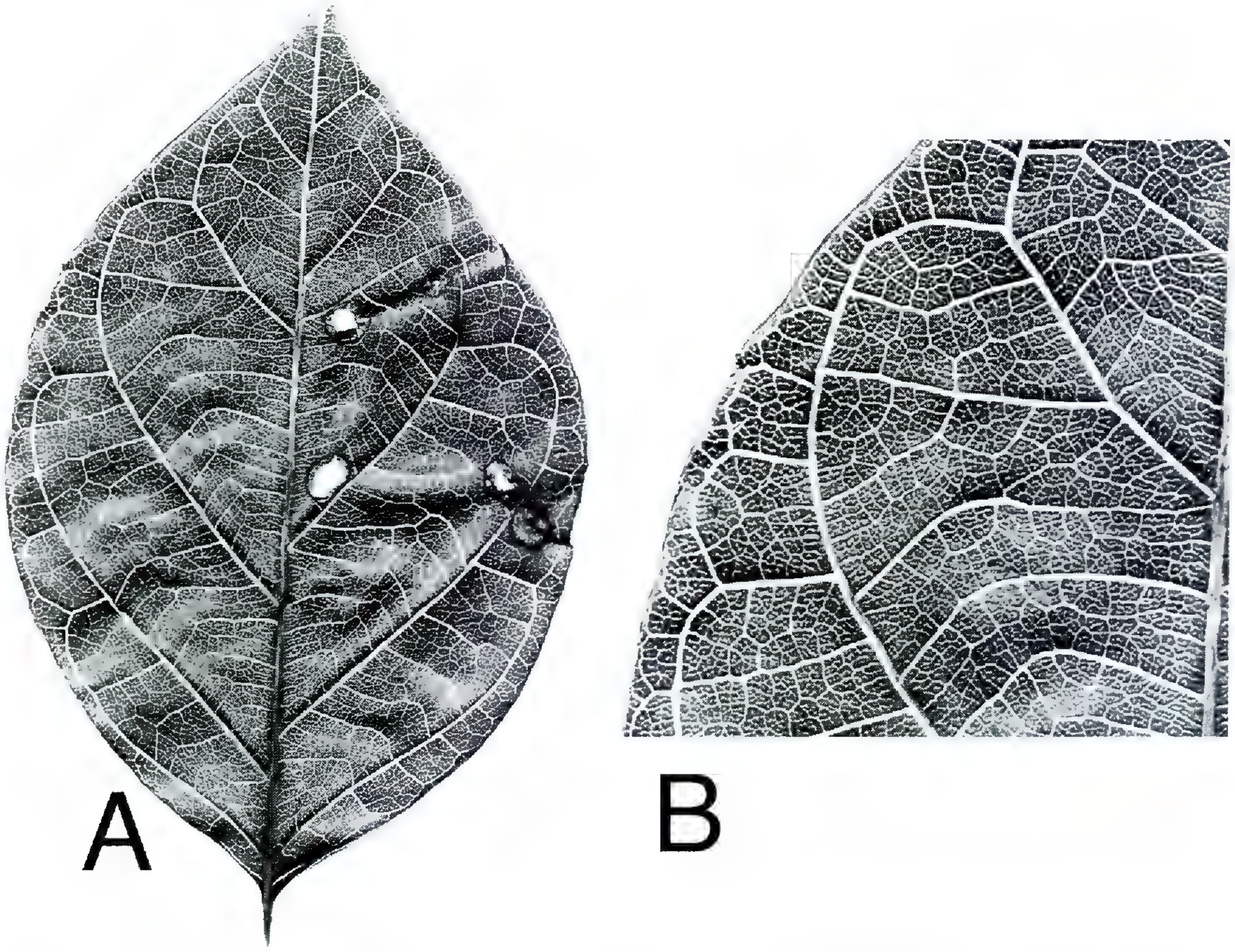


FIG. 2. A, typical leaf of *Campomanesia guabiroba* showing its venation pattern (blade 9 cm long). B, magnified view of portion of same leaf showing detail of venation (*Landrum 2490*, ASU).

or oblanceolate, 4–12(–15) cm long, 2–4(–7.5) cm wide, 1.7–4 times as long as wide; peduncles 0.3–2.6 cm long, uniflorous; bracteoles 1–4 mm long; calyx-lobes hemiorbicular to oblong-truncate, 2–4.3 mm long; hypanthium obconic to campanulate, 1.5–2.5 mm long; stamens 80–90, 4–7 mm long; anthers 0.5–0.8 mm long; ovary 4–6-locular; ovules 4–7 per locule; fruits ca. 1 cm long, black.

Specimens examined. **Mun. Salgado:** Capoeira de mata subperenifólia, 18 Dec 1981, *G.N. Silva 39* (ASE). **Mun. Lagarto:** Caatinga hipoxerófila, 7 May 1982, E. *Carneiro 374* (ASE). **Mun. Itabajana:** Capoeira de caatinga hipoxerófila, 20 Jul 1988, *M. Fonseca 857* (ASE). **Mun. Sta. Luzia do Itanhy:** Mata Atlântica, Mata do Crasto, 3 May 1995, *M. Landim 354* (ASE, ASU, UB).

Although species of *Campomanesia* are usually known locally as "gabiroba" or variations of this name, a specimen collected in the caatinga region was called "cadeia brava."

In his revision of this genus, Landrum (1986) cited only a few collections of *C. aromatica* in the Northeast, namely in the states of Maranhão, Ceará, Rio Grande do Norte, Paraíba and Bahia. The species also occurs in Bolivia (Landrum 1986), an interesting disjunction of over 2000 km. In the present study, it has

been found in areas of coastal forest (Mata Atlantica) as well as caatinga, a shrubby vegetation of dry areas. A greater sampling effort is needed to better understand the distribution of this species.

Campomanesia dichotoma (O. Berg) J.R. Mattos

Shrub or tree up to 10 m high; leaves mature at anthesis, elliptic, elliptic-oblong, ovate or suborbicular, 3–9.5 cm long, 1.5–6 cm wide, 1–2.3 times as long as wide; peduncles 2–6 cm long, bearing 3–15 flowered dichasia; bracteoles ca. 2 mm long; calyx nearly closed in the bud, the calyx-lobes 1–2 mm long, the calyx tearing between the lobes at anthesis; hypanthium (including closed calyx) 5–8 mm long; stamens 200–350, 3–10 mm long; anthers 0.8–1 mm long; ovary 6–10-locular; ovules 7–18 per locule; fruits ca. 1 cm long.

Specimens examined: **Mun. Santa Luzia do Itanhy:** Mata Atlântica, Mata do Crasto, 19 Apr 1995, *M. Landim 333* (ASE, UB), 3 May 1995, *M. Landim 356* (ASE, ASU, UB), 12 Jun 1995, *M. Landim 406* (ASE, ASU, UB), 24 May 1996, *M. Landim and V.M. Schettino 920* (ASE, ASU)

The common name "bacalhau" is used for this species as well as the more common generic designation of "gobiraba."

Campomanesia dichotoma is known from the coastal region of the Northeast of Brazil and the state of Rio de Janeiro (Landrum 1986). So far in Sergipe, examples have been found in only one fragment of Atlantic coastal forest.

Campomanesia guaviroba (A.P. de Candolle) Kiaerskou

Tree up to ca. 12 m high; leaves mature at anthesis, mainly elliptic, less often ovate, lanceolate, suborbicular, or ovate, 4–13 cm long, 1.7–8 cm wide, 1.4–3 times as long as wide; peduncle 0.3–2.5 cm long, uniflorous; bracteoles ca. 4 mm long; calyx-lobes broadly triangular or rounded, 1.5–3 mm long; hypanthium obconic to campanulate, 4–6 mm long; stamens 250–500, 3–9 mm long; anthers 0.5–1 mm long; ovary 7–14-locular; ovules 13–20 per locule; fruit 1–3.5 cm long, yellow or orangish. (Fig. 1 B).

Specimens examined. **Mun. Santa Luzia do Itanhy:** Mata Atlântica, Mata do Crasto, 3 May 1995, *M. Landim 346* (ASE, UB), 25 Apr 1996, *M. Landim 906* (ASE, ASU).

Until recently *Campomanesia guaviroba* was known only from Brazil's Atlantic forest from Espirito Santo to Rio Grande do Sul and adjacent Argentina and Paraguay (Landrum 1986). The collections cited above extend the range far to the north (ca. 1200 km) and are the only ones known to us from the Northeast of Brazil. Recently a collection has extended the known range to Bolivia [Santa Cruz, Velasco Province, Parque Nacional Noel Kempff Mercado, 5 km S del campamento Las Gamas (14° 48'14"S, 60° 23'59"W), 850 m, *A Rodriguez & J. Surubi' 558* (ASU)]. It thus has a disjunct distribution similar to that of *C. aromatica*.

In one area of São Paulo (Mantovani 1993) this species was represented by only two individuals, having an I.V.I of 0.58. Apparently rare, it was not found in the forest gap areas in the same study, although other Myrtaceae were, e.g.,

Eugenia, *Marlieria*, *Calyptranthes*, *Myrcia* and *Gomidesia*. This may mean that it is less tolerant of disturbance (anthropogenic or not) and thus is at a higher risk of going extinct through habitat disturbance and fragmentation.

Campomanesia viatoris Landrum

Shrub or tree to ca. 12 m high; leaves mature at anthesis, elliptic to ovate, 3–13 cm long, 2–6.5 cm wide, 1.5–2 times as long as wide; peduncle 0.5–2 cm long, uniflorous or bearing a 3-flowered dichasium; bracteoles ca. 3 mm long; calyx-lobes truncate-auriculate, 1–3 mm long; hypanthium 8–10 mm long, attenuate at base, constricted near summit of ovary; stamens ca. 300, 4–8 mm long; anthers ca. 1–2 mm long; ovary 7–8-locular; ovules 11–16 per locule; fruit globose except for an attenuate base, up to ca. 2.5 cm in diameter. (Fig. 1 A).

Specimens examined. **Mun. Sto Amaro das Brotas:** restinga, 10 Dec 1981, *G. Viana 294* (ASE). **Mun. São Cristóvão:** restinga, 21 Mar 1985, *G. Viana 1112* (ASE). **Mun. Pirambu:** Reserva Biológica Santa Isabel, dunas no km 11 de praia na direção de Ponta dos Mangues, 28 Jan 1992, *C. Farney et al. 2944* (ASU). **Mun. Santa Luzia do Itanhy:** cerca de 2.5 km do Distrito de Crasto, na estrada para Sta. Luzia do Itanhy, 27 Nov 1993, *A.M.A. Amorim et al. 1500* (ASU); Mata Atlântica, 7 Apr 1995, *M. Landim 282* (ASE, ASU, UB), 3 May 1995, *M. Landim 355* (ASE, ASU, UB), 5 Jul 1995, *M. Landim 456* (ASE, ASU, UB); Mata Atlântica, Mata do Crasto, 7 Apr 1995, *M. Landim 285* (ASE, ASU, UB), 16 Dec 1996, *M. Landim 1108* (ASE, ASU). **Mun. São Cristóvão:** restinga, 9 Apr 1996, *M. Landim 904* (ASE, ASU). **Mun. Areia Branca:** Mata, Serra de Itabaiana, 28 Mar 1997, *A. Vicente 7* (ASE).

The common names for this species are "guabiraba," "gabiroba," "gabirobinha," "gobirabinha," and "gobiraba."

Until recently only two collections for this species were known, the type and one other, both from Alagoas (Landrum 1986). The type was collected by Gardner over 150 years ago and the additional specimen has no date. Since the species was thought to be extinct or near extinction, Landrum (1986) urged botanists in Alagoas to search for this rare species. The collections cited above from Sergipe indicate that *Campomanesia viatoris* is at least locally common in the state and additional specimens have also been found in Bahia. [e.g., Mun. Apora, 31 km S of Olindina along highway BR-116, 310 m, 1 Apr 1976, *G. Davidse et al. 11758* (ASU)].

The anthers of *Campomanesia viatoris* anthers are unusually elongate and similar to those of *C. laurifolia*. This unusual shared anther morphology may indicate an interesting pollination mechanism deserving more careful study.

DISCUSSION

Phytogeographic analysis of species of Myrtaceae is greatly hampered by the difficulty in identifying material, due to the fact that American species of Myrtaceae often are very similar in the majority of their characters (McVaugh 1968), and because of the cryptic nature of the characters used to identify the genera (Landrum and Kawasaki 1997). Some floristic and/or phytosociological studies list great numbers of species or individuals of Myrtaceae, but authors often are unable to identify them to species or genus (e.g., Guedes 1992). In

a study of the flora of Atlantic rainforest, Myrtaceae are cited as the family with the greatest number of unknown specimens (Siqueira 1994).

Ecological studies of the Northeast of Brazil will require many more specialists to identify the great number of collections unknown to species, genus, or even family (Siqueira, 1994). Three conditions need to be improved: **1)** there needs to be more collecting in general as this paper demonstrates; **2)** monographers must study the flora of the Northeast and include specimens from the regional herbaria; and **3)** there should be a greater investment in training more specialists.

The absence of reports of *Campomanesia* in Sergipe in Landrum's 1986 revision of the genus reflects the low sampling effort in the state until recently. It is still difficult to describe the distribution of the species in the state because they are known from so few collections. The present study indicates the existence of a flora that is still relatively unknown in the fragments of Atlantic rainforest in Sergipe and indicates the importance of the exploration and conservation of these areas.

The sympatric occurrence of these four *Campomanesia* species in one fragment, the Mata do Crasto, in Santa Luzia do Itanhy, a coastal region in the south of the Sergipe, provides opportunities for more studies. These might involve the identification of possible differences between these four species in flowering and fruiting phenology, pollinators and fruit predators, and reproductive isolating mechanisms that may have led to speciation.

Finally, it is worth noting that even in regions with forest coverings insufficient to be registered in some national surveys, such as Sergipe, the forest remnants that do exist are the last representatives of an entire ecosystem, including plants, animals, fungi, and micro-organisms. These fragments, mostly of medium to small size, are the best possible estimation of the original ecosystem that will ever be available. Studies on the composition of these fragments can contribute to the preservation of that ecosystem at the regional level and will be useful for future reforestation programs. In order to avoid the drastic loss of large portions of biodiversity, the establishment of reserves is necessary, at least for some of these fragments, and conservation management that includes corridors between fragments as well as the involvement of neighboring human communities in this process is desirable

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BIOLOGICAL STATUS OF *HEDYOTIS NIGRICANS* VAR. *GYPSOPHILA* (RUBIACEAE) IN TEXAS

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Terrell (2001) presented a taxonomic study of the genus *Stenaria* (= *Hedyotis nigricans* and closely related cohorts, sensu Turner 1995). In this he recognized *H. nigricans* var. *gypsophila* as occurring in Trans-Pecos, Texas, citing among his "selected representative specimens" four sheets (cf. Fig. 1), two from Culberson Co., a north-south ridge of limestone outcrops extending for ca. 50 miles from near Van Horn, Texas to near the New Mexico border, and one from the same mountain range in closely adjacent Hudspeth Co.; the fourth collection (*Webster 4501*, MICH) was said to be from the "Madera Canyon" in igneous soils of Jeff Davis County.

Terrell distinguished *H. nigricans* var. *gypsophila* (Fig. 3) from the rest of his concept of the wide-ranging, highly variable *H. nigricans* by the following couplet:

1. Leaves more or less elliptical, 2.5–3.5(–4) times longer than wide; Mexico and south west Texas _____ var. **gypsophila**
1. Leaves usually filiform, linear, narrowly lanceolate, or oblanceolate, more than 4 times longer than wide; corollas 2–8 mm long _____ [var. **nigricans** and closely related cohorts]

Careful scrutiny of the above key will show that the only meaningful character used by Terrell to define his "var. *gypsophila*" is leaf shape. Indeed, Terrell, himself (2001), states that "the most conspicuous character [distinguishing between these elements] is the elliptical leaves on rather small plants...[and] I cannot find any other characters significantly different from var. *nigricans*..."

Regardless, I would like to place on record here that I take many, if not most, of the specimens cited by Terrell (2001) as occurring outside of the regional distributions of *H. n.* var. *gypsophila* (Turner 1995) to be misidentifications of *H. n.* var. *nigricans*, these but leaf and/or habital forms occurring among otherwise typical populations of var. *nigricans*.

This can be readily attested to by reference to the single sheet (*Webster 4501*) of *H. nigricans* var. *gypsophila* cited in the above introduction. A duplicate of this collection at SRSC (Fig. 2) is clearly linear-leaved and could not be identified as var. *gypsophila* by Terrell's key to varieties. Additionally, its habit and floral features do not conform to those of var. *gypsophila* as described by Turner (1995). Indeed, I have reexamined 200 or more specimens of *H. n.* var. *nigricans*

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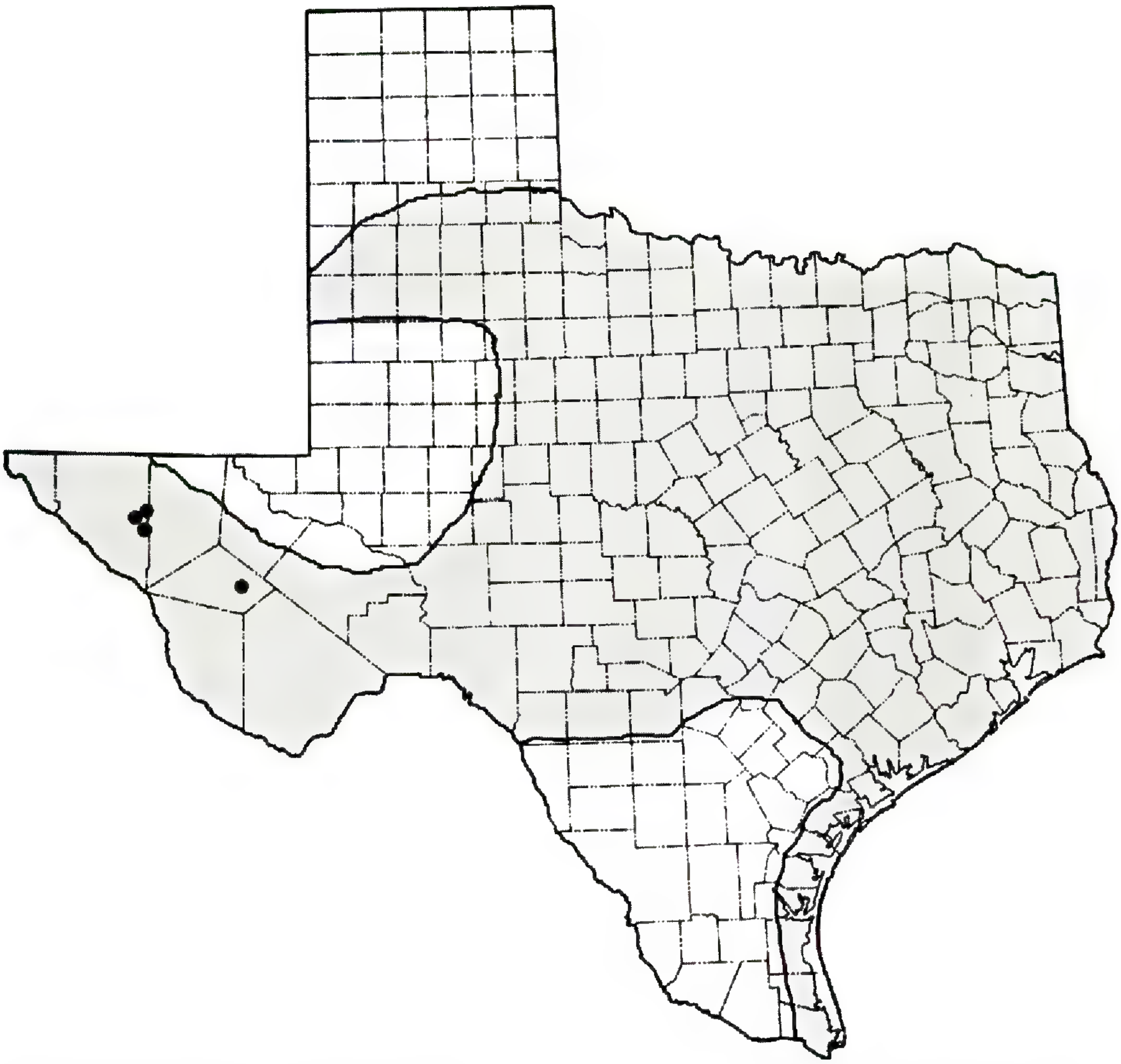


FIG. 1. Generalized distribution of *Hedyotis nigricans* var. *nigricans* in Texas (sensu Turner 1995); dots represent specimens of *H. nigricans* var. *gypsophila* cited by Terrell (2001); I take these to be atypical or misidentified specimens of *H. nigricans* var. *nigricans*.

from Trans-Pecos, Texas (LL, SRSC, TEX) and find not a single plant referable to *H. n.* var. *gypsophila*, including most of the specimens so cited by Terrell (2001).

He further ventures that "I [Terrell] consider the taxon as misnamed, as I recorded only one collection out of 49 Mexican collections from 19 herbaria that mentioned a gypsum substrate. It may be noted that the type specimen came from a gypsum habitat."

However, had Terrell examined the 49 sheets of this taxon on file at LL,TEX he would have found 12 sheets with labels noting their occurrence on gypsum substrates, and most of the rest from areas known to possess such soils. The truth is that most early collectors did not know the difference between gypsum substrates (CaSO4) and limestone substrates (CaCO4), or else they ignored such distinctions. The highly endemic flora occurring on gypsum substrates need

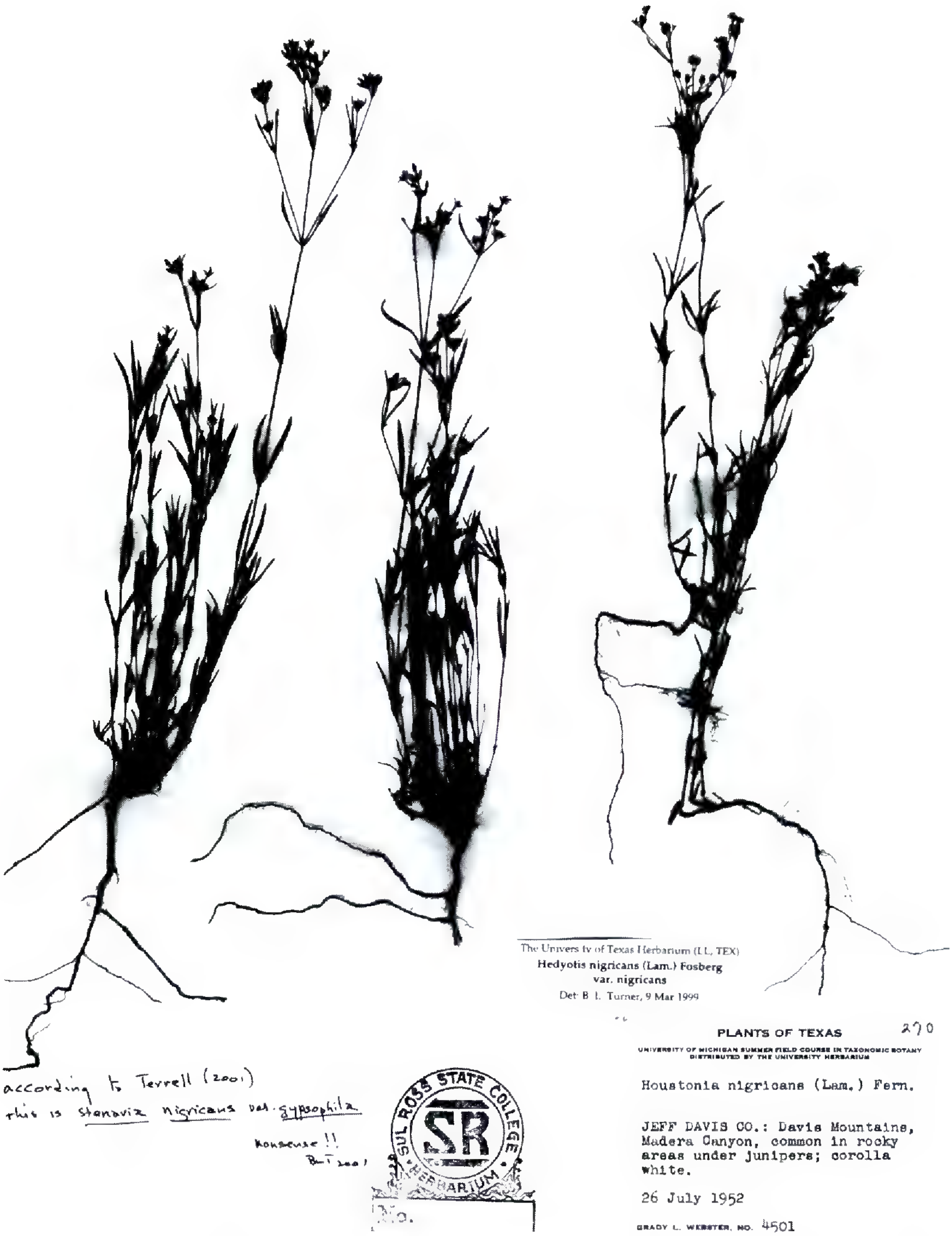


Fig. 2. ***Hedyotis nigricans*** **var.** ***nigricans*** **(sensu Turner 1995); duplicate of** ***Webster 4501*** **(SRSC); which Terrell recognized as** ***H. nigricans*** **var.** ***gypsophila*****. Holotype of the latter is pictured in Fig. 3.**

not be reiterated, this phenomenon being well documented by Powell and Turner (1977) and Turner and Powell (1979).

It should be noted that Terrell seemingly ignored my published comment (Turner 1993) that "This taxon [var. *gypsophila*] is represented by 45 or more



FIG. 3. Holotype of *Hedyotis nigricans* var. *gypsophila* (TEX); according to Turner (1995) populational units of this taxon are confined to mostly gypsum outcrops of southernmost Coahuila, Nuevo Leon, San Luis Potosi and closely adjacent southernmost Tamaulipas, Mexico.

collections at LL, TEX, mostly obtained from gypseous soils in the state of Nuevo Leon." This is not to say that occasional plants of var. *gypsophila* in north central Mexico might not approach var. *nigricans* in this or that character, but such "intermediates" do not occur in Texas. Indeed, var. *nigricans* can be found in relatively close proximity to var. *gypsophila* in Nuevo Leon without clear intermediates, the former occurring on calcareous soils (e.g., *Hinton* et al. *24351, 24575, 25940*, etc., all TEX), the latter on gypseous soils (e.g., *Hinton et al. 24373, 27183*, etc., TEX). In fact, my initial taxonomic sense was to recognize var. *gypsophila* as specifically distinct, but such treatment would deny the occasional intermediates, these mostly occurring in regions of near geographical contact.

It should be emphasized that var. *gypsophila* is distinguished from var. *nigricans* by more than habit, leaf shape and calyx vestiture. The upper leaf surfaces of the former are more nearly papillose; those of the latter having surface-sculpturing more like that of the epidermis of a peanut. In short, there are a syndrome of characters which provide for the recognition of both taxa, although the occasional plant from this or that population might lack one or another of the characters concerned.

Such identification problems are touched upon by numerous workers, including my own (Turner et al. 1988). Leaf shape and habit vary considerably among populations of var. *nigricans* in Texas. Thus, heavily browsed plants will appear much branched from the base, and newly produced basal shoots will possess somewhat broader leaves. No doubt such plants occasioned the attribution of var. *gypsophila* to Texas, and probably those Mexican collections cited by Terrell as occurring outside the distribution of var. *gypsophila* sensu the present author.

Finally, I can't help but note that I currently live among populations of *H. nigricans* var. *nigricans* in Trans-Pecos, Texas, and have examined numerous populations from throughout this region and nearly all consist of plants identifiable as var. *nigricans* as defined by both Terrell and myself, except as how one might let the occasional over-browsed plant cloud one's identification.

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DOCUMENTED CHROMOSOME NUMBERS 2002: 1. CHROMOSOME NUMBER OF *STENANTHIUM* (LILIALES: MELANTHIACEAE) AND ITS SIGNIFICANCE IN THE TAXONOMY OF TRIBE MELANTHIEAE

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ABSTRACT

Mitotic chromosome counts for *Stenanthium densum* and *S. leimanthoides* ($2n = 20$), reported here for the first time, match the number previously documented for *S. gramineum*, the only other species in this genus as recently recircumscribed based on molecular data. The significance of chromosome numbers in the Melanthiaceae, particularly as generic synapomorphies in tribe Melanthieae, is discussed.

RESUMEN

El recuento de cromosomas mitóticos de *Stenanthium densum* y *S. leimanthoides* ($2n = 20$), reportados por primera vez aquí, concuerdan con el número previamente documentado para *S. gramineum*, la única otra especie de este género recircumscrito recientemente basándose en datos moleculares. Se discute aquí el significado del número de cromosomas en Melanthiaceae, particularmente como sinapomorfías genéricas en la tribu Melanthieae.

The Melanthiaceae sensu the Angiosperm Phylogeny Group (APG 1998) comprise five tribes (11–16 genera; ca. 154–201+ spp.) of predominately woodland and/or alpine perennial herbs occurring mainly in the temperate to Arctic zones of the Northern Hemisphere (with one species of *Schoenocaulon* extending into South America; Zomlefer et al. 2001). Of concern here are two genera of the tribe Melanthieae, *Stenanthium* s.l. and *Zigadenus* s.l. As traditionally and broadly circumscribed, both genera form poorly defined complexes (summary in Zomlefer 1997). *Stenanthium* s.l. has sometimes been divided into two genera: a monotypic *Stenanthium* (*S. gramineum*) and *Stenanthella* (2–4 spp.); *Zigadenus* has a more complex taxonomic history involving several proposed segregates, although contemporary botanists have typically accepted only the monotypic segregate *Amianthium* with the remaining ca. 19 species maintained in *Zigadenus* s.l.

The circumscription and relationships of genera within the tribe Melanthieae were recently evaluated using parsimony analyses of ITS (nuclear ribosomal) and *trnL-F* (plastid) DNA sequence data (Zomlefer et al. 2001). Based on the cladograms generated in this study, *Zigadenus* s.l. is polyphyletic and

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Stenanthium s.l. is biphyletic, with *Stenanthium* s.s. and *Stenanthella* embedded within two different "*Zigadenus*" clades. In overview, the species of *Stenanthium* and *Zigadenus*, as traditionally circumscribed, form five strongly supported clades that correlate with distinctive geographical distribution, chromosome number, and certain morphological characters. The *Stenanthium* clade, comprising *Stenanthium gramineum* (*Stenanthium* s.s.), *Zigadenus densus*, and *Z. leimanthoides*, is defined by the morphological synapomorphies of a slender (cylindrical) bulb and one obscure (or lacking) gland per tepal. However, the chromosome number for this group, $2n = 20$, has been documented only for *Stenanthium gramineum* (Miller 1930; Satô 1942; as *S. robustum*, see Fernald 1946). Since chromosome number is a significant feature for genera of tribe Melanthieae, 20 was predicted as the likely mitotic count for the other two species now transferred to the recircumscribed *Stenanthium*, *Stenanthium densum* and *S. leimanthoides* (Zomlefer et al. 2001; Zomlefer & Judd 2002).

MATERIALS AND METHODS

Several plants of *Stenanthium densum* and *S. leimanthoides* were collected during April to June 2001 (see Table 1) and transplanted to pots maintained at the Plant Biology Dept. Greenhouse Facility at the University of Georgia and the Biology Dept. Greenhouse at High Point University. Dividing root tip cells were prepared for examination according to general protocols outlined by Flory and Smith (1980), Jones and Luchsinger (1986), and Smith (1984). Once the plants were well-established, actively growing root tips were harvested at noon and treated with 0.2 % colchicine for 4 hours, rinsed in distilled water, and then fixed in Carnoy's solution (3 ethanol: 1 acetic acid) overnight or longer. Following this fixation, the roots were rinsed in distilled water, hydrolyzed in 1.0 N HCl at 43° C for 25 minutes, macerated with a dissecting spatula on a glass microscope slide, and stained with 1% aceto-orcein. After application of a cover slip, the slide was gently heated with an alcohol lamp, placed between blotters, and subjected to additional pressure. Slides were mounted in euparal for future reference. Well-spread metaphase chromosomes were traced under a Leica DMLB Research Microscope with a camera lucida attachment. Herbarium specimen vouchers (Table 1) are deposited at GA.

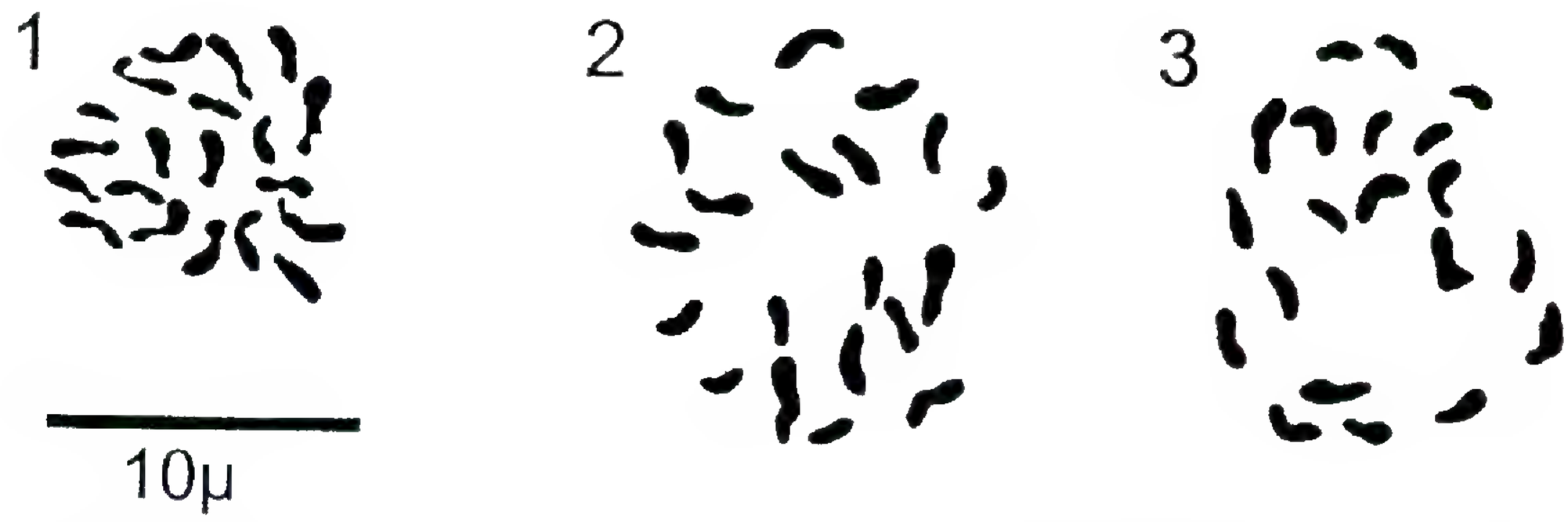
RESULTS AND DISCUSSION

The mitotic chromosome number of $2n = 20$ for *Stenanthium*, as circumscribed by Zomlefer and Judd (2002), is verified for all species (Table 1, Figs. 1–3). Chromosome number is a useful taxonomic character for genera within tribe Melanthieae (see Fig. 4), especially the synapomorphic $2n$ numbers of 20 for *Stenanthium* and 22 for *Toxicoscordion*. A probable base chromosome number of $x = 8$ is often cited for the tribe Melanthieae (Sen 1975; Tamura 1995; Lowry et al.

TABLE 1. Distinguishing features of *Stenanthium densum* and *S. leimanthoides* (from Zomlefer 1997), and voucher specimens for the chromosome numbers reported in this study. Based on reports of morphologically intergrading populations in Mississippi (McDearman 1984), some authors (e.g., Sorrie & Weakley 2001) regard these taxa as conspecific. Despite some overlap in habitat, morphology, and phenology, Small (1903) considered these taxa as two separate monotypic genera (*Tracyanthus* and *Oceanoros*).

Taxon	Distribution, habitat, distinguishing characters, & phenology	Locality & collection number (voucher location)	Mitotic chromosome number (*2n*)
Stenanthium densum (Desr.) Zomlefer & Judd	se VA to e LA Flatwoods, bogs Plants delicate, racemes simple, flowers perfect Apr -May	FLORIDA. Franklin Co.: E side of FL 65, 1.1 mi N of Ft. Gadsden Creek, 4 Apr 2001 *Zomlefer 782* (GA)	20
		FLORIDA. Liberty Co.: W side of FL 379, 0.2 mi N of Forest Service Rd. 180, 4 Apr 2001, *Zomlefer 783* (GA)	20
Stenanthium leimanthoides (A. Gray) Zomlefer & Judd	Wider range: NY to ne TX Pinelands, bogs, montane marshes, swamps Plants strikingly more robust, racemes compound, flowers perfect + staminate (plants andromonoecious) May–June	GEORGIA. Taylor Co.: 4.3 mi N of Butler, 0.25 mi E of GA137, 21 May 2001, *Zomlefer 792* (GA)	20
		GEORGIA. Taylor Co.: 6.1 mi S of Butler, Little Whitewater Creek, W side of GA 137, 18 Jun 2001, *Zomlefer 797* (GA)	20

1987; Zomlefer 1997), and multiples of this number (or perhaps of 4) are prevalent in the group (Fig. 4): *Anticlea* (which includes *Stenanthella*), *Schoenocaulon*, and sister groups *Amianthium* and *Veratrum* (including *Melanthium*). Unfortunately, due to the small chromosome size of members of the tribe (ca. 2.0–4.0 µm in length), the few karyotype studies (e.g., Lee 1985) are not detailed enough to infer a possible mechanism of chromosomal evolution, although the chromosome numbers (Fig. 4) indicate the prevalence of polyploidy and/or aneuploid variation. The functional outgroup for Melanthieae (see Zomlefer et al. 2001), *Z. glaberrimus* (*Zigadenus* s.s.), has an unpublished count of $2n = 52$, tentatively reported by Preece (1956). Probable base numbers for the other immediate outgroup taxa of the tribe Melanthieae (the remaining four tribes of the Melanthiaceae) are five and 15, respectively, for sister taxa Parideae



FIGS. 1–3. Mitotic chromosomes of the three species of *Stenanthium*, all *2n* = 20. 1. *S. gramineum* [modified from Satô (1942), Fig. 58]. 2. *S. densum* (*Zomlefer 782*). 3. *S. leimanthoides* (*Zomlefer 792*).

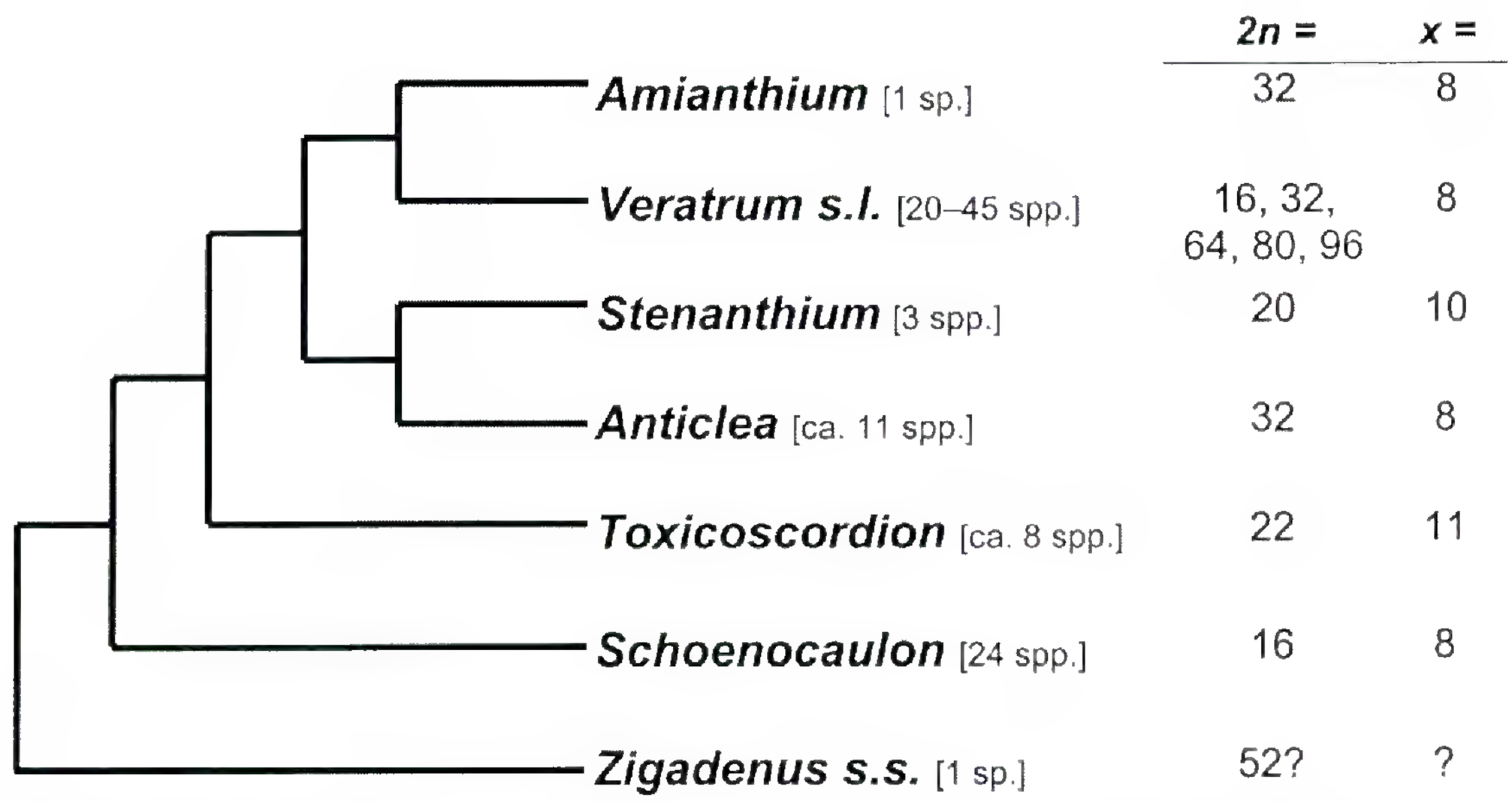


FIG. 4. Phylogenetic relationships and reported chromosome numbers for the genera of tribe Melanthieae. The cladogram, modified from Zomlefer et al. (2001), is based on ITS and *trnL-F* sequence data; chromosome numbers are from references summarized in Zomlefer (1997). As circumscribed here, *Amianthium*, *Stenanthium*, *Anticlea*, *Toxicoscordion*, and *Zigadenus* s.s. all contain species of the polyphyletic *Zigadenus* s.l. (Zomlefer & Judd 2002).

(Trilliaceae) and Xerophylleae, and 17 and possibly six, respectively, for sister taxa Heloniadeae and Chionographideae (Lowry et al. 1987; Zomlefer 1996, 1997).

Confirmation of the chromosome number for *Z. glaberrimus* (a possible polyploid) and the reassessment of the base number for the tribe merit further investigation (Zomlefer in prep.), especially in relation to the probable base numbers of the other tribes. Available data, however, already demonstrate that chromosome number strengthens support for the monophyly of *Toxicoscordion* and *Stenanthium*, as recircumscribed. Chromosome counts for the superficially similar plants in the Melanthieae validate chromosome number as a signifi-

cant character, useful for elucidating and predicting groupings and relationships. Variation in chromosome number has also proven phylogenetically significant in other monocot clades, such as *Polygonatum*/Polygonateae (Tamura 1993; Tamura et al. 1997a, b).

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DOCUMENTED CHROMOSOME NUMBERS 2002: 2. CHROMOSOME NUMBERS IN NORTH AMERICAN SPECIES OF *CERASTIUM* (CARYOPHYLLACEAE)

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ABSTRACT

Chromosome numbers are reported for 85 collections of *Cerastium* (Caryophyllaceae) from continental North America belonging to 22 taxa. First published reports include those for *C. nutans* var. *objectum* Kearney & Peebles ($2n = 34$) and *C. texanum* Britton ($2n = 36$). First reports for material of North American origin include *C. bialynickii* Tolm. ($2n = 108$), *C. brachypodum* (Eng. ex Gray) B.L. Robinson ($2n = 34$), *C. dichotomum* L. ($2n = 38$), *C. diffusum* Pers. ($2n = 72$), *C. fischerianum* Ser. ($2n = 66$ & 72), *C. glomeratum* Thuill. ($2n = 72$) and *C. semidecandrum* L. ($2n = 36$).

RESUMEN

Se citan los números cromosomáticos de colecciones de *Cerastium* (Caryophyllaceae) de Norte América continental pertenecientes a 22 taxa. Entre ellos se encuentran los primeros recuentos de *C. nutans* var. *objectum* Kearney & Peebles ($2n = 34$) y *C. texanum* Britton ($2n = 36$). Primeros recuentos en materiales de origen norteamericano de *C. bialynickii* Tolm. ($2n = 108$), *C. brachypodum* (Eng. ex Gray) B.L. Robinson ($2n = 34$), *C. dichotomum* L. ($2n = 38$), *C. diffusum* Pers. ($2n = 72$), *C. fischerianum* Ser. ($2n = 66$ & 72), *C. glomeratum* Thuill. ($2n = 72$) y *C. semidecandrum* L. ($2n = 36$).

INTRODUCTION

The purpose of this paper is to put on record previously unpublished data on chromosome numbers in the species of *Cerastium*, both native and introduced, occurring in continental North America.

METHODS AND MATERIALS

Mitotic chromosomes were studied in root-tip preparations. Plants were raised in the greenhouse, either from seed or from material transplanted from the wild. Root-tips were taken from actively growing plants, prefixed for about one hour in a saturated aqueous solution of paradichlorobenzene and fixed in 1:3 glacial acetic acid and ethanol (absolute). They were hydrolyzed in N hydrochloric acid at 60°C for 10—15 minutes and squashed in aceto-carmine. In a few cases flower buds were used for counts of meiotic chromosomes. The buds were fixed in Carnoy's Fluid (acetic acid 1:chloroform 1:ethanol 3). Developing anthers were teased out and squashed in aceto-carmine or aceto-orcein. The cultivated plants were grown to maturity and voucher specimens taken for comparison with those collected in the wild. Voucher specimens are retained in the author's re-

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TAB. 1. Chromosome numbers in *Cerastium*. Collection numbers prefixed with NA are J.K. Morton or J.K. Morton and Joan M. Venn collections.

Taxon	Locality & collection number	Chromosome no. (2*n*)
C. alpinum L. subsp. *alpinum*	Nfld.: Northern Peninsula – St. Anthony *NA5272 & NA5275*	72
	N.W.T.: Gt. Slave Lake *Cody 16059*	72
	Ont.: Lake Superior – Leadman Is. *NA4532*	72
	Ont.: Hudson Bay – SE of Winisk *Sims 2304*	108
	Que.: James Bay – Gt. Whale River *Forest & Brisson s.n.*	*72*
C. alpinum L. subsp. *lanatum* (Lam.) Cesati	Ont.: Hudson Bay Cape Henrietta Maria *Winterhalder* 3512	104±2
C. arcticum Lange	Nun.: Baffin Is. – Fox 2 Dewline Site, *Parmalee & Seaborn 4052a*	108
C. beeringianum Cham. & Schltdl.	Alta.: Kananaskis to Coleman rd., *NA4679*	72
	Alta.: Jasper Nat. Pk. – Wilcox Mt., *Morton s.n.*	72
	Alaska: Taylor Hwy. – Chicken, *NA2122*	72
	Alaska: Alaska Pen. Ugashik, *Talbot 103 25*	72
	B.C.: Alaska Hwy. – Summit Lake, *NA14139 & NA14140*	72
	Calif.: Alpine Co. - Round Top Mt., *Stebbins s.n.*	72
	Colo.: Rocky Mt. Nat. Pk., *NA7334*	72
	Colo.: Mt. Evans, *NA7345*	72
	Nfld.: Northern Pen. – Bellburns, *NA12405*	72
	Nfld.: Cape St. George, *NA5409*	*72*
	N.Mex.: Sante Fe Basin, *NA7144*	*72*
	N.W.T.: Mackenzie Dist. rd to Flat Lake, *Spicer 1638*	72
	N.W.T.: Mackenzie Dist. – Canada Tungsten Mine, *Cody & Spicer 17702*	72
	N.W.T.: Mackenzie Dist. – June Lake, *Cody 17022*	72
	Que.: Gaspé Pen. – Ste. Anne des Montes, *NA2977*	72
	Que.: Gaspé Pen. – Percé, *NA4128*	*72*
	Wyo.: Park Co. Snow Lake, *Scott 976*	72
	Wyo.: Beartooth Mts. – Beartooth Pass, *NA4805*	72
	Yukon: Dempster Hwy. – North Fork Pass, *NA13761*	*72*
	Yukon: Alaska Hwy. – Koidern, *NA2075 & NA2076*	72

TABLE 1. cont.

Taxon	Locality & collection number	Chromosome no. (2*n*)
	Yukon: Taylor Hwy. – on Alaska border, *NA2163*	72
C. bialynickii Tolm.	Nun.: Devon Is., *Bliss s.n.*	108
	Nun.: Axel Heiberg Is., *Kuc 272*	108
C. brachypetalum Pers.	Miss.: Lee Co. – Tupelo, *NA16924*	90
subsp. *tauricum* (Sprengel) Murb.	N.C.: Wilkes Co. – rte 421, 36 mi W of Winston Salem, *NA4385*	88 also n – 44
	N.C.: Rutherford Co. – US-74 between Rutherfordton & Lake Lure, *NA4419*	n – 44
	N.C.: Claiborne Co. – nr Tazewell, *NA14988 & NA14991*	90
C. brachypodum (Eng. ex Gray) B.L. Robinson	Ariz.: Apache Co. – White Mts., *NA7015*	34
	Ariz.: Apache Co. – S of Show Low, *NA16711*	34
C. dichotomum L.	Wash.: Walla Walla Co. – Walla Walla, *Old s.n.*	38
C. diffusum Pers.	Calif.: Mendocino Co. – Fort Bragg, *Morton s.n.*	72
C. dubium (Bast.) Guèpin	Idaho: Gem Co. – Emmett, *Old s.n.*	38
C. fischerianum Ser.	B.C.: Queen Charlotte Is. – Tasu Mt. at ca. 2000 ft., *NA13402*	72
	B.C.: Queen Charlotte Is. – Tasu on mine workings near sea level, *NA13440*	66
C. fontanum Baumg. subsp. *vulgare* (Hartman) Greuter & Burdet	B.C.: Vancouver, *NA13504*	144
	B.C.: Queen Charlotte Is. – Tasu, *NA13403*	144
	N.Mex.: Catron Co. – Mogollon, *Pinkhava 12546*	ca. 122
	Ont.: Bruce Co. – Inverhuron Provincial Park, *NA1493*	144
C. fontanum Baumg. subsp. *vulgare* (a glandular variety)	B.C.: Stewart Hwy. – on W side of summit, *NA13668*	ca. 144
	Man.: Cowan – on rte 10 E of Swan River, *NA4549*	ca. 144
	Ont.: Lanark Co. – nr Almonte, *NA2722*	144
	Ont.: Bruce Pen. – Tobermory, *NA3702*	144
C. glomeratum Thuill.	Calif.: Mendocino Co. – Westport, *Morton s.n.*	72
	Ont.: Middlesex Co. – London, *Oldham 9097*	72
	Yukon: Dawson City, *NA2172*	72

TABLE 1. cont.

Taxon	Locality & collection number	Chromosome no. (2*n*)
C. nutans Raf.	Alta.: rte 16, Vermilion, *NA3796*	36
	Alta.: WNW of Edmonton – Lac St. Anne, *Morton s.n.*	36
	N.Mex.: Grant Co. – NM-90, W of Emory Pass, *NA15933*	36
	Tenn.: Gatlinburg, *NA4443*	36
C. nutans Raf. var. *objectum* Kearney & Peebles	N.Mex.: Catron Co. – Gila Nat. Forest, Willow Ck. campground, *Pinkava et al. 12636*	34
C. pumilum Curtis	B.C.: Vancouver Is. – Saanichton, *NA13548*	72
	Ind.: Huntington Co. – I-69 at exit 73, *NA15024*	72
	N.C.: Robeson Co. – Maxton nr Laurinburg, *NA4408*	72
	Va.: Richmond, *NA2602*	72
C. semidecandrum L.	B.C.: Victoria - McNeil Bay, *NA13565*	36
	Ont.: Bruce Co. – Inverhuron, *Morton s.n.*	36
	Ont.: Essex Co. Point Pelee, *NA3540 & NA4478*	36
C. terrae-novae Fern. & Wieg.	Nfld.: Bonne Bay – Table Mt., *NA12183*	108
C. texanum Britton	Ariz.: Pima Co. – Kitt Peak, *NA11233*	36
	Ariz.: Pima Co. – Nogales, Sycamore Canyon, *Churchill 70 604*	36
C. tomentosum L.	Ont.: Bruce Pen. – N of Wiarton, *Morton s.n.*	72
C. velutinum Raf.	Mo.: Jefferson Co. – De Soto, *NA19069*	72
	N.Y.: New York City – Staten Is., *NA3580*	72
	Ohio: Erie Co. – Catawba Is., Sandusky, *NA3660*	72
	Ont.: Essex Co. – Pelee Is., *Morton s.n.*	72
	Ont.: Essex Co. – Point Pelee, *NA4476*	72
	Pa.: Chester Co. – Nottingham, *NA3571a*	72
C. velutinum Raf. "var. *villosissimum*"	Pa.: Chester Co. – Lees Bridge, *NA3770*	72
C. viride Heller (*C. arvense* L subsp. *maximum* (Hollick & Britt.) Ugborogho)	Calif.: Marin Co. – Pt. Reyes, *NA19200*	72
	Calif.: Mendocino Co. – Fort Bragg, *Stebbins 7007*	72
	Calif.: Sonoma Co. Bodega Beach, *Stebbins s.n.*	72
	Oreg.: Clatsop Co. – Cannon Beach, *Chambers s.n.*	72
	Oreg.: Clatsop Co. Onion Pt., *Chambers 3160*	72

search collections and partial sets of duplicates have been distributed to WAT, MICH, DAO and VDB. Collection numbers prefixed with NA are J.K. Morton or J.K. Morton and Joan M. Venn collections (Table 1).

DISCUSSION

Many of these chromosome counts confirm those from previous workers. However, the following appear to be the first published counts for their respective taxa: *Cerastium nutans* var. *objectum* - $2n = 34$ and *C. texanum* - $2n = 36$. That for *C. terrae-novae* - $2n = 108$, is the first definitive count for that species though Böcher (1977) reported a chromosome number of "lower than 72 (perhaps 68)."

The following chromosome counts appear to be the first published counts for North American material of these alien species: *C. dichotomum* - $2n = 38$, *C. diffusum* - $2n = 72$, *C. glomeratum* - $2n = 72$ and *C. semidecandrum* - $2n = 36$.

Amongst native species that also occur in other regions, that for *C. bialynickii* - $2n = 108$, is new. *Cerastium bialynickii* has not previously been reported from North America, having been originally described from Siberia, where it is reported to have a chromosome number of $2n = 72$. It is a very compact and hispid relative of *C. beeringianum* with obtuse sepals.

Also our count for *C. fischerianum* is the first from this continent. The presence of two different chromosome numbers in adjacent populations of this species is unusual. The differences appear to be genuine, for the preparations were carefully checked. The explanation may be that the population at sea level, with $2n = 66$, was growing in a weedy situation on mine tailings. As *C. fischerianum* frequently intergrades with *C. beeringianum* it is possible that these plants were of hybrid origin.

The count for *C. brachypodum* ($2n = 34$) is the first for North America, but Beaman et al. (1962) reported the same chromosome number in material from Central America.

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Böcher, T.W. 1977. *Cerastium alpinum* and *C. arcticum*, a mature polyploid complex. Bot. Notiser 130:305–309.

BOOK REVIEW

SALLY WASOWSKI. 2002. **Gardening with Prairie Plants: How to Create Beautiful Native Landscapes. Photography by Andy Wasowski.** (ISBN 0-8166-3087-9, pbk.) University of Minnesota Press. 111 Third Avenue South, Suite 290, Minneapolis, MN 55401-2520. (Orders: www.upress.umn.edu, 612-627-1932, 612-627-1980 fax). $29.95, 304 pp, 241 color photos, 335 figures, 8 1/2" × 11".

Most gardening books could be classified informative, educational and instructive. But rarely could a book on gardening be regarded as a page-turner. *Gardening with Prairie Plants* was such a pleasure to read that I had a hard time putting down. Wasowski begins her book by elaborating the on merits of gardening with native prairie plants and remarks "a prairie landscape can also be eye-poppingly gorgeous!" I would characterize this book in a similar light.

Gardening with Prairie Plants is generally divided into three main parts: I. Prairies and Prairie Gardens, II. Design, Installation, and Maintenance, and III. Plant Profiles. The first part defines a prairie, where prairies are located in North America and how prairies vary based on geography. The author follows with many examples of home prairie gardens, which perhaps are described better as testimonials to the advantages of native plant landscapes. Each one of these testimonials more or less describes how the homeowner installed and maintained their gardens, with a color photo and a figure of the landscape design to accompany the text. The next chapter, "Using Preserved and Replicated Prairies as Models", encourages the reader to determine the soil type for their proposed prairie plot and locate a nearby prairie example to model their garden by. Lowland, mesic, upland and sand prairies and savannas are all considered here.

Putting your newfound knowledge of prairies is put to work in Part II. The chapter entitled, "Designing Prairie Gardens", gives advice on planning your garden for your lifestyle and yard. This information is followed by clear and candid advice on garden installation, including preparing a seedbed, tilling and enriching the soil, collecting native seed and planting transplants. As well, readers will know exactly how to maintain their gardens with the author's advice on weed control, irrigation, prescribed burning and mowing. Conducting a safe controlled burn is considered in some detail, with an outline on the proper procedure.

The author's labor shines through in Part III, with the wealth of knowledge provided for each species included in the plant profiles. This part is divided into four chapters, which deal first with grasses, sedges and rushes, followed by warm season forbs, then cool season forbs and finally trees and shrubs. At the end of each chapter, a table is provided of all included species, which serves the reader in quickly identifying species that would grow best in their garden habitat. For each plant listed, information on common and scientific name, some diagnostic characters and habitat preferences are provided. Each species also has a map of its geographic distribution and many species have a lovely photo to accompany the description

To say that the illustrations and photographs in this book are lovely would be a mild understatement. Exquisite and inspiring are two terms that might do them justice. Hats off to Michael Parkey and Andy Wasowski for their illustrations and photographs, respectively. Their work is the eye candy of this treatise. A short glossary of prairie terms, a list of gardening resources listed by state and an index with common and scientific names concludes this book

In sum, this book would be of interest to anyone interested in native landscape gardening—homeowners, landscape architects, Master Gardeners and prairie plant enthusiasts. Those particularly interested in prairie restoration should not be without a copy of this book. It is pure pleasure to read.—*Amy Trauth Nare, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A., amy_trauth@yahoo.com*

USOS DE MELASTOMATACEAE EN EL ECUADOR

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RESUMEN

Melastomataceae es una familia con aproximadamente 4500 especies distribuidas en los trópicos y subtrópicos, principalmente en América del Sur. En Ecuador se han registrado 43 géneros y 553 especies, de éstos, 24 géneros y 124 reportan alguna utilidad para el ser humano.

Según los registros de los herbarios QCNE y QCA y la literatura, las especies ecuatorianas de Melastomataceae son utilizadas principalmente para tratar heridas, picaduras de culebras y para construcciones. De las 124 especies útiles, 27 (21,8%) son alimenticias, especialmente debido a los frutos dulces y a los tallos agrios usados para calmar la sed; 32 (25,8 %) son utilizadas para tablas y construcción; 59 (47,6%) son medicinales; 8 (6,4%) son usados por los shamanes para aliviar algunas enfermedades físicas y espirituales; solamente 4 (3,2%) son ornamentales y 50 (40,3%) tienen otros usos, tales como cabos de herramientas, escobas, encofrados, forraje para animales, leña, tinciones, y como cercas vivas.

ABSTRACT

Melastomataceae is a family with about 4500 species distributed mainly in the tropics, especially in South America. There are 43 genera and 553 species registered for Ecuador. Based on the revision of herbarium specimens housed at QCNE, QCA and the literature, 24 genera and 124 species are registered as useful for humans. Of these, 27 (21.8%) are used as food due to the sweetish fruits and acidic stems, used against thirst; 32 (25.8 %) are used for construction; 59 (47.6%) are medicinal; 8 (6.4%) are used by Shamans for treating fisical and spiritual ailments; only 4 (3.2%) are ornamentals; and 50 (40.3%) have various uses, such us for tools handles, brooms, fuelwood, charcoal, dyes, and for living fences.

INTRODUCTION

El Ecuador incluye 553 especies (Renner et al. 1999) de las 4500 existentes en el mundo (Mabberley 1997). Registros de usos de Melastomataceae, junto con otras familias de plantas se han concentrado principalmente a áreas o a grupos étnicos determinados del país. Así, Cerón (1996) registra los usos de plantas del Parque

Nacional Machalilla (prov. de Manabí), Kvist y Holm-Nielsen (1987), basados en sus estudios en la comunidad indígena Cayapa (prov. de Esmeraldas) y en la literatura, describen rituales curativos y usos de plantas por comunidades indígenas de las tierras bajas. Para la región Andina, Kothari (1993) lista las plantas usadas por pobladores de La Esperanza, comunidad indígena Zuleta (prov. de Imbabura), Cerón (1996) reporta los usos de plantas de la Reserva Geobotánica Pululahua (prov. de Pichincha), Ríos (1993) lista las plantas de una comunidad mestiza del noroccidente de Pichincha, Elleman (1991) publica los usos maderables realizados por la comunidad Saraguro (prov. de Loja), y Cueva (1997) y Van den Eynden (1997) listan las plantas alimenticias de la provincia de Loja. Muchos otros trabajos etnobotánicos han sido realizados en comunidades indígenas de la Amazonía ecuatoriana, entre ellos podemos citar a Alarcón (1988), Cerón (1996), Cerón y Montalvo (1998), Lescure et al. (1987) y Vickers y Plowman (1984). A una mayor escala geográfica, Schultes y Raffauf (1990) presentan usos etnobotánicos de Melastomataceae y demás familias de angiospermas presentes en la Región Amazónica Nororiental.

La ausencia de publicaciones sobre los usos de la familia a nivel del Ecuador nos motivó a la recopilación de información sobre nombres vernaculares, usos actuales y potenciales de especies de Melastomataceae a partir de las etiquetas de especímenes depositados en los dos herbarios con mayor número de colecciones del país (QCNE y QCA).

METODOLOGIA

La información sobre usos de plantas se la obtuvo a partir de los especímenes con información etnobotánica depositados en el Herbario Nacional del Ecuador (QCNE) y herbario de la Pontificia Universidad Católica del Ecuador (QCA), ambos en Quito. De cada especimen se recopiló el nombre de la especie, el colector y número, el nombre vernacular e idioma (si presentes), y los usos. La determinación de los especímenes botánicos depositados en ambos herbarios fue realizada principalmente por Elvira Cotton (actualmente en el Herbario AAU, Aarhus, Dinamarca), especialista en Melastomataceae ecuatorianas quien residió en Ecuador por varios años. Información publicada en la literatura, y aquella producto de nuestra experiencia de campo también fueron incluídos en el presente trabajo. Datos sobre el número total de especies por género fueron tomados de Renner (1993) y Mabberley (1997), e información sobre el número de especies por género y su distribución en el Ecuador se obtuvo de Wurdack (1980), Renner et al. (1999) y Freire-Fierro (en prensa). El material examinado está listado en el Anexo, en el cual se incluyen a los autores de los nombres científicos.

Aciotis D. Don

Este género herbáceo incluye 13 especies, y en Ecuador se registran cuatro especies que se distribuyen principalmente en las faldas occidentales de la Cor-

dillera Occidental y en las faldas orientales de la Cordillera Oriental. *Aciotis rubricaulis*, una especie distribuída a ambos lados de la cordillera es utilizada para curar picaduras de culebras. Similar uso se registra para *Aciotis ornata*, especie que en Ecuador se distribuye únicamente en las tierras bajas al noroccidente. Cerón (1994) registra el uso de *Aciotis leoyara* (probablemente refiriéndose a *A. levyana* Cong., un sinónimo de *A. rubricaulis* [Freire-Fierro (en prensa)]) como antiofídica.

Arthrostemma Pavón ex D. Don

Este género arbustivo presenta siete especies, y solamente *Arthrostemma ciliatum* está registrada en el Ecuador, en donde se distribuye en la región costera, andina y amazónica. Esta especie es utilizada para curar la diarrea en niños y para curar dolores de garganta. Los tallos suculentos son un tanto acídicos y son generalmente utilizados para calmar la sed. Esta especie también podría ser utilizada como ornamental debido a su hábito trepador y flores de un vistoso color rosado.

Axinaea Ruiz y Pavón

Este género arbóreo o arbustivo consta de 30 especies, 10 de las cuales ocurren en los Andes del Ecuador. De éstas, *Axinaea affinis*, *A. macrophylla*, *A. quitensis*, y *A. sclerophylla* son utilizadas principalmente para la construcción y como combustible en calidad de leña y carbón. Un potencial uso del género sería como ornamental ya que las flores son bastante vistosas.

Dos especies de *Axinaea* son consideradas maderables, *A. macrophylla* por Cerón (1994) y *A. sclerophylla* (como *A. schlerophylla)* por Elleman (1991).

Bellucia Neck. ex Raf.

Este género arbóreo consta de siete especies, y solamente *Bellucia pentamera* está registrada en el Ecuador, en donde se distribuye en la Costa, Andes y Amazonía. La madera de esta especie es utilizada para la construcción. Los frutos, que nacen directamente de los troncos, pueden alcanzar hasta 10 cm de diámetro, son comestibles y de sabor ligeramente dulce.

El fruto maduro de *Bellucia pentamera* (como *B. weberbaueri* Cogn.) es comestible para los Kichwas (como Quichuas) de la Amazonía Ecuatoriana (Alarcón 1988, Lescure et al. 1987) y por colonos mestizos de la comunidad Ahuano (provincia del Napo) (Ríos y Caballero 1997). El nombre *Bellucia axinthera* (probablemente refiriéndose a *B. axinanthera* Triana, un sinónimo de *B. pentamera)* es listado como alimenticio por Cerón (1994).

Blakea P. Browne

Este género arbustivo incluye 100 especies, 31 de las cuales ocurren en el Ecuador, en donde se distribuyen en la Costa, Región Andina y Amazonía. *Blakea bracteata*, *B. glandulosa*, *B. involvens*, *B. punctulata*, *B. rosea*, y *B. subconnata* son utilizadas para tratar heridas, picaduras de culebras, y prevenir ampollas. También son utilizadas para curar el "enduendado" [hechizo] y para la construcción de casas.

Especies de este género también tienen gran potencial ornamental, especialmente para reforestar parques y avenidas debido a que sus flores son bastante llamativas, puesto que existe un contraste entre los pétalos, generalmente rosados, con los estambres y estaminoides que son de un amarillo dorado.

El espécimen *Vickers* y *Plowman* 255 (QCA) listado como "*Blakea* aff. *ciliata* Mgf. or *B. rosea*" por Vickers y Plowman (1984), y como *B. rosea* por Lescure et al. (1987), es conocido por los Siona-Secoyas como "Yayurua" y es utilizado para tratar quemaduras. *B. sawadae* es utilizada por los Cofanes como medicinal (Cerón 1994). *B. portentosa* Wurdack es conocida por los Huaoranis como "Namuntaqui" y tiene frutos que son consumidos por aves pequeñas (Cerón y Montalvo 1998).

Brachyotum (A. DC.) Triana

Brachyotum es un género arbustivo de 58 especies, 21 de las cuales ocurren en el Ecuador, en donde se distribuyen únicamente en los Andes. Cinco especies, *Brachyotum alpinum*, *B. azuayense*, *B. ledifolium*, *B. rostratum* y *B. trichocalyx* son utilizadas para curar el catarro en los pollos, teñir, construír, así como para leña y escobas. Este género puede ser también utilizado como cercas vivas. Algunas especies de *Brachyotum* tienen potencial como ornamental ya que sus flores presentan generalmente cálices de un color rojo vivo y corolas morado oscuras (e.g. *Brachyotum andreanum* Cogn.) o amarillas (e.g. *B. ledifolium*); sin embargo, las plantas tendrían que ser sembradas especialmente en lugares fríos ya que el género es típicamente de páramo.

Brachyotum ledifolium es utilizada medicinalmente por los Kichwas andinos (Cerón 1994) y como combustible y para escobas en la zona del Pululahua (Cerón 1996).

Clidemia D. Don

Este género arbustivo incluye 120 species, 38 de las cuales ocurren en el Ecuador, en donde se distribuyen tanto en la Costa, Región Andina como Amazonía. Las siguientes 14 especies son utilizadas: *Clidemia acostae*, *C. allardii*, *C. capitellata*, *C. crenulata*, *C. dentata*, *C. dimorphica*, *C. epiphytica*, *C. heterophylla*, *C. hirta*, *C. ostrina*, *C. purpurea*, *C. septuplinervia*, *C. sprucei* y *C. variifolia*. Estas especies son utilizadas para tratar heridas, úlceras, diarrea con sangre, así como para cicatrizar, calmar el mareo, y bajar la fiebre. Además, una de estas especies es utilizada por los shamanes para "asustar a los espíritus", especialmente los "malos" espíritus [entidades sobrenaturales que pueden hacer daño]. Debido a que las bayas son agri-dulces, éstas son utilizadas para calmar la sed. Muchas especies de *Clidemia* presentan formicarios en la base de las hojas o en los tallos y tienen asociación con hormigas, las cuales utililizan estas estructuras como sus nidos. Los formicarios tienen un sabor ácido debido a esta situación y son consumidos como alimento por algunos grupos étnicos de la Amazonía.

Clidemia dentata, conocida como "Paitzi", es utilizada por los Kichwas de

la Amazonía ecuatoriana para bajar la fiebre (como *Clidemia* sp., Alarcón 1988, Lescure et al. 1987). Los frutos de *C. dimorphica* y *C. sprucei* son comestibles para los indígenas Huaoranis (Lescure et al. 1987), y es también conocida como medicinal por los Cofanes (Cerón 1994). Los indígenas Kichwas y mestizos de la comunidad Ahuano (provincia del Napo), también consumen los frutos de una especie de *Clidemia* no determinada (Ríos y Caballero 1997). *Clidemia heterophylla* es listada como medicinal por Cerón (1994).

Conostegia D. Don

Conostegia es un género arbustivo de 43 especies, 16 de las cuales ocurren en Ecuador, en donde se distribuyen principalmente en la Costa, aunque también se han registrado especies para la Región Andina y la Amazonía. *Conostegia attenuata*, *C. centronioides* y *C. dentata* son utilizadas para curar enfermedades [no especificadas en las etiquetas].

Diplarpea Triana

Este género herbáceo o arbustivo tiene solamente una especie, la cual está presente en el Ecuador. *Diplarpea paleacea* ocurre en los flancos de la cordillera norte andina y es utilizada para tratar dolores de estómago.

Graffenrieda DC.

Este género arbustivo o arbóreo consta de 44 species, 11 de las cuales existen en Ecuador, y están distribuídas principalmente en la región andina. Dos especies del género, *G.* aff. *intermedia* y *Grafferieda* sp. son utilizadas en la construcción y como leña por los Huaoranis de Quehueiri-Ono (provincia del Napo) (Cerón y Montalvo 1998).

Henriettella Naudin

Este género arbustivo o arbóreo incluye 51 species, siete de las cuales se encuentran en Ecuador, tanto en las tierras bajas como en los flancos occidental y oriental de los Andes. De acuerdo a Ríos y Caballero (1997), el fruto de una especie no identificada es conocida como comestible por los pobladores Kichwas y mestizos de la comunidad de Ahuano (provincia del Napo).

Leandra Raddi

Este género arbustivo incluye 175 especies, 19 de las cuales ocurren en el Ecuador, en donde se distribuyen principalmente en la Amazonía, aunque también hay registros de la Región Andina y de la Costa. *Leandra caquetana*, *L. caquetensis*, *L. granatensis*, *L. secunda* y *L. subseriata*, son utilizadas como comestibles por sus frutos, y para curar ulceraciones de la piel. Los pequeños frutos carnosos son comidos por las aves.

Loreya DC.

Loreya es un género arbustivo que comprende 14 especies. De las cuatro especies ecuatorianas, una se distribuye en la Costa y las tres restantes en la Amazonía. De acuerdo a Lescure et al. (1987), los frutos de *Loreya spruceana* (bajo *L. collatata*

Wurdack) son comestibles. Estos frutos también son comidos por tapires y puercos salvajes (-bajo *L. collatata* -Schultes y Raffauf 1990).

Maieta Aubl.

Este género arbustivo incluye únicamente dos especies, y ambas se distribuyen en la Amazonía ecuatoriana. De éstas, *Maieta guianensis* es utilizada para tratar dolores estomacales, y de cabeza, mareos, y para cicatrizar heridas. Esta especie también tiene frutos carnosos que son comidos por las aves.

Meriania Sw.

Este género arbustivo y arbóreo consta de 74 especies, 27 de las cuales ocurren en el Ecuador. Una sola especie está registrada para la Costa y las restantes se distribuyen en los Andes. Los troncos de *Meriania tomentosa* son utilizados para la elaboración de carbón (Cerón 1996). Este género también tendría gran potencial para forestación de parques y avenidas por las vistosas flores. Aunque este último uso no se da en el Ecuador, en Colombia especies del género son utilizadas como árboles ornamentales de avenidas (D. Neill, com. pers. 2001).

La madera del "Quihle o Quishle blanco," una especie indeterminada de *Meriania*, es utilizada en la construcción por los Saraguros (Elleman 1991).

Miconia Ruiz y Pav.

Miconia es el género más grande de la familia, incluye aproximadamente 1000 especies, 240 de las cuales están registradas para el Ecuador. La mayoría de especies son andinas, aunque también ocurren en la Costa y en la Amazonía. La alta diversidad de especies es acompañada por la diversidad de usos de especies de *Miconia* en el Ecuador. En los herbarios revisados se tienen registradas como medicinales a las siguientes especies: *Miconia affinis, M. barbinervis, M. bracteolata, M. bubalina, M. crocea, M. erioclada, M. goniostigma, M. gracilis, M. lugonis, M. nervosa, M. paleacea, M. papillosa, M. procumbens, M. theaezans, M. trinervia, M. triplinervis, M. venulosa*, y *M. zubenetana*, las que son utilizadas como vermífugo, para estimular las dilataciones durante el parto, curar dolores de garganta y del cuello, tratar la tuberculosis, dolores de muelas, infecciones bucales, micosis, sarnas y para curar diarrea de niños recién nacidos, e inclusive pueden ser utilizadas como antídoto de picaduras de la hormiga "Conga" (*Paraponera* spp.) (ver Cerón 1994, 1996, Cerón y Montalvo 1998; Schultes y Raffauf 1990). *Miconia bubalina* (como *Miconia* sp.) es utilizada por los Kichwas de la amazonía para tratar pequeños abcesos (Alarcón 1988; Lescure et al. 1987).

La madera de *Miconia aeruginosa, M. astroplacama, M. aureoides, M. brachycalyx, M. bracteolata, M. bubalina, M. caelata, M. corymbiformis, M. crocea, M. decurrens, M. floribunda, M. lutescens, M. matthaei, M. napoana, M. obscura, M. ochracea, M. paleacea, M. papillosa, M. pustulata, M. salicifolia, M. splendens, M. subspicata*, M. *theaezans*, y *M. tinifolia*, es utilizada principalmente para construcción, para fabricación de herramientas, producción de carbón y como

combustible (Ver Cerón 1994, 1996; Cerón y Montalvo 1998; Cueva 1997; Elleman 1991; Van den Eynden 1997; Lescure et al. 1987; Schultes y Raffauf 1990; Vickers y Plowman 1984). De acuerdo a Cerón y Montalvo (1998), otra especie utilizada en la construcción y leña es *Miconia ternifolia* Triana, sin embargo, este nombre no está registrado en el Catálogo de Plantas Vasculares del Ecuador (Renner et al. 1999) ni en la base de datos TROPICOS (Missouri Botanical Garden 2002).

Si bien los frutos bacáceos de *Miconia* alcanzan hasta 1 cm de diámetro, algunos son dulces y comestibles, tal es el caso por ejemplo de *Miconia asclepiadea*, *M. aspergillaris*, *M. crocea*, *M. latifolia*, *M. ledifolia*, *M. lutescens*, *M.* cf. *splendens* y *M. theaezans* (Ver Cerón 1994, 1996; Cerón y Montalvo 1998; Cueva 1997; Van den Eynden 1997).

Los frutos de *Miconia bubalina*, *M. calvescens*, *M. cazaletii*, *M. centrodesma*, *M. cercophora*, *M. decurrens*, *M. nervosa* y *M. oraria* son comidos por aves (Ver Cerón y Montalvo 1998).

Algunas especies tendrían también potencial ornamental, por ejemplo, *Miconia crocea* tiene panículas de cerca de 20 cm de longitud con abundantes flores con pétalos blancos y estambres amarillos. Otra especie con potencial ornamental podría ser *Miconia salicifolia*, la cual se distribuye en la Región Andina y presenta arbustos con apariencia de candelabros debido a la densa y erecta disposición de los tallos y a la posición adpresa de las hojas, las cuales muestran la densa pubescencia ferruginosa-amarilla de su envés.

Los indígenas Kichwas de la Amazonía ecuatoriana utilizan una especie no determinada de *Miconia* conocida como "Chiquitapayansu" para tratar granos infectados (Alarcón 1988). La madera de *M. astroplacama* es utilizada por los Siona-Secoyas para pilares en construcción de casas (Lescure et al. 1987; Vickers y Plowman 1984). Los frutos de otra especie no identificada de *Miconia*, y conocida por los Kichwas como "Payanzo", son comestibles (Lescure et al. 1987). Los frutos de *M. ledifolia*, *M. lutescens* y dos especies no determinadas son comestibles en la provincia de Loja (Cueva 1997; Van den Eynden 1997). Cerón (1994) registra el uso de *Miconia crocea* en la medicina y *M. palacea*, *M. pustulata* y *M. theaezans* en la construcción. Elleman (1991) lista como maderables para los Saraguros a *M. caelata*, *M. corymbiformis*, *M. obscura*, *M.* cf. *tinifolia* y dos especies no identificadas.

Monochaetum (DC.) Naudin

Este género arbustivo incluye 45 especies, y solamente tres están registradas para el Ecuador, en donde se distribuyen en la región andina. *Monochaetum hartwegianum* es utilizado como ornamental y *M. lineatum* para leña. Esta última especie es conocida como maderable por los Saraguros (Elleman (1991).

Monolena Triana

Monolena es un género herbáceo de 10 especies, y únicamente *M. primulaeflora*

está registrada tanto en la Costa y Región Andina como en la Amazonía ecuatoriana. Esta especie es utilizada para tratar la gripe, dolores de estómago, parásitos intestinales, conjuntivitis, siendo además usada como antiofídica. Debido al sabor ácido de los pecíolos suculentos, esta especie también es utilizada para calmar la sed. *Monolena primulaeflora* podría ser explotada como planta de interior debido a que las hojas acaulescentes tienen pecíolos rojizos y suculentos, láminas variegadas y flores bastante llamativas.

Kvist y Holm-Nielsen (1987) mencionan que esta especie es usada por los Coaiqueres como vermífuga y que es fuertemente hemética, y Cerón (1994) la lista como laxante. Schultes y Raffauf (1990) registran el uso de la misma especie para tratamientos de mordeduras de serpientes en la provincia de Pastaza.

Mouriri Aubl.

Este género arbóreo consta de 81 especies, 10 de las cuales se han registrado para el Ecuador, en donde ocurren principalmente en la Amazonía. De las tres especies registradas como útiles, *M. oligantha* es utilizada como anticonceptivo y esterilizante; y los frutos de *Mouriri grandiflora* y *M. nigra* son comestibles. Su uso como comestible está registrado también por Cerón (1994).

Ossaea A.P. DC.

Ossaea es un género arbustivo con 91 especies, 20 de las cuales ocurren tanto en la Costa y Amazonía ecuatoriana como en los Andes. El Ecuador tiene cinco especies útiles: *Ossaea bracteata*, *O. laxivenula*, *O. micrantha*, *O. quadrisulca*, y *O. robusta*. Los herbarios estudiados registran que estas especies han sido utilizadas para bajar la fiebre y tratar la epilepsia. Los frutos están registrados como comestibles.

Una especie identificada como *Ossaea* sp. [muestra *Alarcón 34*] y conocida por los Kichwas de la Amazonía ecuatoriana como "Hagapania/Payanzo" es utilizada para tratar granos infectados y sarna (Alarcón 1988; Lescure et al. 1987). En realidad, este espécimen fue más tarde identificado como *Miconia affinis*.

Tessmanianthus Markgr.

Este género arbóreo neotropical incluye siete especies, de las cuales dos están registradas para la Amazonía ecuatoriana. Aunque no se estudió material de herbario de este género, Cerón y Montalvo (1998) indican que el fuste de *T. heterostemon* Markgr. es utilizado por los Huaoranis de Quehueri-Ono para la construcción y para leña.

Tibouchina Aubl.

Este género arbustivo incluye 240 especies. Solamente 14 especies están registradas para el Ecuador, las cuales se distribuyen principalmente en los Andes, aunque también existen especies en la Costa y Amazonía. Siete especies, *Tibouchina gleasoniana*, *T. grossa*, *T. laxa*, *T. lepidota*, *T. longifolia*, *T. mollis*, y *T. oroensis* son utilizadas para tratar cataratas, extraer sarcoma de los ojos, tratar dolor de muelas, para forraje de los animales, leña o uso ornamental.

Tibouchina lepidota es muy común en la región andina nor-oriental, y podría ser utilizada no solo como combustible, sino también como ornamental. Las inflorescencias están compuestas de grandes flores con colores blancos, rosados y fucsias y con estambres amarillos vistosos. Con la excepción de *Tibouchina oroensis*, las otras especies de *Tibouchina* ornamentales observadas en el Ecuador son importadas del Brasil (D. Neill, com. pers. 2001).

El uso como combustible de *Tibouchina mollis* está registrado en Cerón (1994).

Tococa Aubl.

Tococa comprende cerca de 50 especies de plantas arbustivas usualmente mirmecófilas. Ecuador posee 12 especies distribuidas principalmente en las tierras bajas de la Amazonía, existiendo menos en la Región Andina y la Costa. *Tococa guianensis* es utilizada para tratar los granos infectados de la piel. Los especímenes examinados también registran que los frutos de *T. spadiciflora* y de *T. symphandra* son comidos por las aves. Aunque las etiquetas de los especímenes herborizados no lo registren, es posible que las pequeñas y vistosas bayas de otras especies de *Tococa* sean también comidas por aves.

Tococa guianensis (-erróneamente escrita "*Cococa*") es utilizada por los Kichwas de la Amazonía ecuatoriana para curar granos infectados y es conocida como "Payanshu" (Alarcón 1988), o como "Jatunpayanshu" (Lescure et al. 1987). Los frutos maduros de esta misma especie, bajo el sinónimo *Tococa chuivensis* Wurdack var. *ecuadorensis* Wurdack, son comidos por personas y por aves (Cerón y Montalvo 1998).

Triolena Naudin

Triolena es un género herbáceo de 22 especies, 11 de las cuales se encuentran en Ecuador, especialmente en las tierras bajas tanto de la Costa como de la Amazonía. *Triolena hirsuta*, *T. obliqua*, *T. pluvialis*, *T. pedemontana*, y *T. pustulata* son utilizadas en Ecuador como medicinales. Estas especies son utilizadas principalmente para tratar picaduras de culebras, reducir las subsiguientes hinchazones, y para tratar tuberculosis y tos.

Los Cayapas y Coaiqueres utilizan *Triolena* para tratar mordeduras de culebras, y los Siona-Secoyas usan *T. pluvialis* para tratar dolores de muelas (Kvist y Holm-Nielsen 1987; Vickers y Plowman 1984). Similar uso es dado para esta especie por los Kichwas de la Amazonía ecuatoriana (Alarcón 1988; Lescure et al. 1987) y por los Cofanes (Schultes y Raffauf 1990). Cerón (1994) también registra el uso medicinal de esta especie.

CONCLUSIONES Y DISCUSION

El presente trabajo se basó primordialmente en la compilación de la información de las etiquetas de dos herbarios ecuatorianos. Contrariamente a la opinión generalizada de que Melastomataceae no es una familia etnobotánicamente

TABLA 1. Porcentajes de especies por tipos de usos de las 124 especies de Melastomataceae utilizadas en Ecuador. Nota: El número total de especies (177) aparece mayor que el real (124) debido a que 46 especies tienen al menos dos usos.

Usos	Número spp. útiles	Porcentaje
Medicina	59	47,6
Otros	50	40,3
Construcción	32	25,8
Alimenticio	27	21,8
Mágico Religioso	8	6,4
Ornamental	4	3,2

importante (e.g. Schultes y Raffauf 1990), al menos una de cada cinco especies que ocurre en Ecuador tiene alguna utilidad.

Más de la mitad de los géneros registrados para el Ecuador son útiles, sin embargo, a pesar de que algunos géneros están presentes en el país y de ser citados en la literatura como útiles (e.g. *Adelobotrys* DC. y *Centronia* D. Don [Schultes y Raffauf 1990]), no registran uso alguno en Ecuador.

La mayoría de especies de Melastomataceae (Tabla 1) es utilizada medicinalmente, en segundo lugar está el uso para leña, carbón, alimentos de animales, tinciones, etc. [Otros]; una de cada cuatro especies útiles de la familia es usada en la construcción, menos del 22% de especies es utilizado en la alimentación, muy pocas especies son utilizadas en rituales mágico religiosos y solamente cuatro de las 124 especies es utilizada como ornamental. Según Schultes y Raffauf (1990), sin embargo, la única importancia económica que la familia tiene es por las especies ornamentales. Probablemente esta discrepancia se deba a que si bien en Ecuador Melastomataceae no es muy utilizada a nivel ornamental, este uso es común en otros países.

Debido a la diversidad de especies, *Miconia* es el género que mayor número de especies útiles presenta, principalmente en la construcción, medicina y usos varios. *Clidemia* es el segundo género más importante (14 especies útiles) y la mayoría de sus especies es utilizada en la medicina, aunque *C. crenulata* es también utilizada en ritos mágico religiosos. En tercer lugar están *Blakea* y *Tibouchina*, géneros con 7 especies útiles cada uno. Los otros géneros tienen de una a cinco especies útiles. A nivel de especies, *Miconia theaezans*, *Blakea subconnata*, *Miconia bracteolata*, *Miconia bubalina*, *Miconia crocea*, y *Ossaea micrantha* registraron el mayor número de usos, tanto en la alimentación, como en medicina y construcción.

A nivel de uso, *Arthrostema* y *Monolena* son los más utilizados para calmar la sed debido a sus hábitos suculentos y de sabor ácido; y *Bellucia*, *Henriettella*, *Mouriri*, y *Ossaea* son predominantemente usados como alimenticios debido a que sus frutos son relativamente grandes y bastante dulces. Las especies de

Axinaea, *Bellucia*, *Graffenrieda*, y *Tessmanianthus* son las más utilizadas en la construcción, especialmente debido al hábito arbóreo de las mismas. Más del 60% de las especies de *Aciotis*, *Arthrostema*, *Blakea*, *Clidemia*, *Conostegia*, *Diplarpea*, *Maieta*, *Monolena*, *Ossaea*, y *Triolena*, son utilizadas medicinalmente. A nivel mágico religioso, *Aciotis* es el más utilizado y menos del 50% de las especies de *Blakea*, *Clidemia*, *Conostegia*, *Miconia*, y *Ossaea* es también usado para este fin; ninguno de los otros géneros registrados para Ecuador es utilizado para el mismo propósito. De los 24 géneros usados en Ecuador, únicamente *Monochaetum* (*M. hartwegianum*) y *Tibouchina* (*T. gleasoniana* y *T. grossa*) son en la actualidad utilizados como ornamentales. Más del 55% de las especies de los géneros arbóreos y arbustivos *Axinaea*, *Brachyotum*, *Graffenrieda*, *Loreya*, *Meriania*, y *Tibouchina* es utilizado primordialmente para carbón, leña o por la fauna local como alimento.

De las 124 especies útiles, 13 de ellas (cerca del 10%) fueron citadas en la literatura pero no estaban representadas en los dos herbarios (Cerón 1994, 1996, Cerón y Montalvo 1998; Elleman 1991; Ríos y Caballero 1997), y de las 111 especies restantes, solamente 36 (32%) fueron citadas en estudios etnobotánicos anteriores (Alarcón 1988; Cerón 1994, 1996; Cerón y Montalvo 1998; Cueva 1997; Elleman 1991; Freire-Fierro en prensa; Kvist y Holm-Nielsen 1987; Lescure et al. 1987; Ríos y Caballero 1997; Schultes y Raffauf 1990; Van den Eynden 1997; Vickers y Plowman 1984). Esta compilación da una pauta sobre la necesidad de publicar información que de otra manera permanece restringida únicamente a los investigadores locales, quienes podrían darla a conocer a la comunidad internacional por medio de publicaciones similares en otras familias de plantas.

La información sistemática sobre usos de Melastomaceae podría servir de base por ejemplo, para la búsqueda de principios activos en las especies listadas como medicinales; o para la selección de especies para la construcción y ornato que mejor podrían crecer en determinada región geográfica; o para estudios ecológicos de las especies útiles endémicas, especialmente de aquellas amenazadas de extinción (Cotton 2000); para futuros planes de manejo sustentable y conservación. Adicionalmente, estudios etnobotánicos y de campo, enfatizados en la familia, podrían verificar los usos de Melastomataceae registrados aquí y en la literatura.

ANEXO

Material de Melastomataceae examinado en los herbarios QCA y QCNE. Usos: A = Alimenticio; C = Construccción; M = Medicinal; MR = Mágico-Religioso, O = ornamental; R = Otros. Distribución (Jørgensen y León 1999, Renner et al. 1999, Freire-Fierro en prensa): AZU = Azuay, BOL = Bolívar, CAÑ = Cañar, CAR = Carchi, CHI = Chimborazo, COT = Cotopaxi, ORO = El Oro, ESM = Esmeraldas, GUA = Guayas, IMB = Imbabura, LOJ = Loja, RIO = Los Ríos, MAN = Manabí, MOR = Morona Santiago, NAP = Napo, PAS = Pastaza, PIC = Pichincha, SUC =

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
Aciotis ornata (Miq.) Gleason	ESM			x	x				*Barfod 41016* (QCA)	Freire-Fierro (en prensa)
Aciotis rubricaulis (Schrank y Mart. ex DC.) Triana	CAR, ORO, ESM, IMB, MOR, NAP, PAS, PIC, TUN, ZAM			x				Chulco, Pin tape (Y)	*Barfod 41478* (QCA), *Kvist y Asanza 40745* (QCA)	Cerón (1994)*, Freire-Fierro (en prensa)
Arthrostemma ciliatum Pav. ex D. Don	BOL, CHI, COT, ORO, ESM, GUA, LOJ, RIO, MAN, MOR, NAP, PAS, PIC, ZAM	x		x				Agro Viro, Shimujcu, Schji-moh-co (Y)	*Barfod 48053* (QCA), *Bensman 134* (QCA), *Lawesson 39656* (QCA), *Yánez et al. 1401* (QCNE)	
Axinaea affinis (Naudin) Cogn.	CAÑ, CAR, IMB, LOJ		x				x	Colca	*Morán y Paisano 104* (QCA, QCNE)	
Axinaea macrophylla (Naudin) Triana	AZU, CAÑ, CAR, CHI, IMB, LOJ, MOR, PIC, SUC, ZAM		x				x	Amarillo	*Tipaz 98* (QCA, QCNE)	Cerón (1994)
Axinaea quitensis Benoist	BOL, CAÑ, CHI, COT, IMB, LOJ, NAP, PIC, TUN		x					Guihle (S)	*Ellemann 9876* (QCNE)	
Axinaea sclerophylla Triana	AZU, LOJ, MOR, ZAM		x				x	Amarillo, Palo blanco (S)	*Cuamacas et al. 158* (QCNE), *Ellemann 9862* (QCNE)	Elleman (1991)
Bellucia pentamera Naudin	CAR, ESM, IMB, MOR, NAP, PAS, SUC, ZAM	x	x					Manzana del silvestre, Payanzo (K), Quisa muyu yura (K), Sacha guayaba (K),	*Alarcón 120* (QCA), *Baker 6154* (QCA), *Balslev y Alarcón 3030* (QCA, QCNE), *Irvine 417*	Alarcón (1988)*, Cerón (1994)*, Lescure et al. (1987)*, Ríos y

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
								Tamia muyu (K), Tunguia (U)	(QCA), *Palacios 558* (QCNE), *Ríos 358* (QCA)	Caballero (1997), Schultes y Raffauf (1990)*
Blakea bracteata Gleason	MOR, NAP, PAS, SUC			x				Huasca payatsi (K)	*Freire y Cerda 10* (QCA, QCNE)	
Blakea glandulosa Gleason	MOR, NAP, PAS, TUN			x				Uchan panga (K)	*Hurtado y Alvarado 296* (QCA, QCNE)	
Blakea involvens Markgr.	BOL, RIO, PIC			x				Quirdo (O)	*Kvist 40049* (QCA)	
Blakea punctulata (Triana) Wurdack	CAR, ESM		x					Pilmo	*Barfod 41613* (QCA)	
Blakea cf. *rosea* (Ruiz y Pav.) D. Don	MOR, NAP, PAS			x				Hïrï khaki (F), Shashapi (K), Shashaqui (A), Yayurua (I)	*Lewis et al. 14045* (QCNE), *Ríos 343* (QCA), *Vickers 255* (QCA)	Lescure et al. (1987), Schultes y Raffauf (1990), Vickers y Plowman (1984)
Blakea sawadae J.F. Macbr.	MOR, NAP, PAS			x				Ttembaccópicho (F)		Cerón (1994)
Blakea subconnata O. Berg ex Triana	AZU, BOL, CAR, COT, ORO, ESM, GUA, IMB, RIO, NAP, PIC, TUN	x			x		x	Cacha micite, Kin mullu-chua (Y), Peí-ca (Y), Quinlulo tape (Y)	*Barfod 48336* (QCA), *Kvist 40297* (QCA), *Kvist 40497* (QCA), *Tipaz et al. 1228* (QCA, QCNE)	
Brachyotum alpinum Cogn.	AZU, BOL, CHI, IMB, MOR, PIC, TUN						x	Urco fichana (K)	*Cerón et al. 11785* (QCA, QCNE)	
Brachyotum azuayense	AZU, LOJ			x			x	Guillo yuyo (S), Quillo	*Ellemann 9904* (QCNE),	

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
Wurdack								yuyo	*Ellemann 66933* (QCA), *Ellemann 75440* (QCA)	
Brachyotum ledifolium (Desr.) Triana	BOL, CAR, CHI, COT, IMB, NAP, PIC, TUN			x			x	Lengua de gato, Puca-chaglla (K), Quijol	*Cerón et al. 6883* (QCA, QCNE), *Núñez 75* (QCA, QCNE), *Tinajero 127* (QCA)	Cerón (1994, 1996)
Brachyotum rostratum (Naudin) Triana	AZU, LOJ, MOR, NAP		x				x	Quilloyuyu	*Ellemann 66862* (QCA)	
Brachyotum trichocalyx Triana	AZU, LOJ						x	Escoba colorada	*Ellemann 66575* (QCA)	
Clidemia acostae Wurdack	IMB, RIO, PIC	x							*Jaramillo 7012* (QCA)	
Clidemia allardii Wurdack	CAR, MOR, NAP, PAS, SUC	x		x				Chuegimo, Oa.-/'do-tapé (Y),	*Barfod 41060* (QCA), *Mendoza 85* (QCA)	
Clidemia capitellata (Bonpl.) D. Don	ESM, IMB, NAP, PAS, ZAM			x				Aéwáéñiwáé	*Oldeman 84* (QCA)	
Clidemia crenulata G eason	ESM			x	x			Oá-do-tape (Y), P'n-remedio-tapé (Y)	*Barfod 41061* (QCNE), *Barfod 48077* (QCA)	
Clidemia dentata Pav. ex D. Don	CAR, CHI, COT, ESM, GUA, IMB, LOJ, RIO, MAN, MOR, NAP, PAS, PIC, SUC, TUN, ZAM			x				Paitzi (K)	*Alarcón 19523* (QCA)	Alarcón (1988)*, Lescure et al. (1987)*
Clidemia dimorphica J.F. Macbr.	MOR, NAP, PAS, SUC, ZAM		x		x			Aéwáéñiwáé (H), Icsa nanai yura, Sambiri'si	*Oldeman y Arévalo 79* (QCA), *Ponce 236* (QCA, QCNE)	Cerón (1994), Lescure et al. (1987)
Clidemia epiphytica	CAR, COT, ESM,			x				Pishunguy tape (Y),	*Kvist y Asanza 40371*	

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
(Triana) Cogn.	RIO, MOR, NAP, PAS, PIC, SUC							Sacha-uchan-panga	(QCA, QCNE)	
Clidemia heterophylla (Desr.) Gleason	NAP, PAS			x				Situli panga (K), Uchán (K), Uchanpanca (K)	*Asanza y Neill 79* (QCA, QCNE)	Cerón (1994), Schultes y Raffauf (1990)
Clidemia hirta (L.) D. Don	ORO, ESM, LOJ, NAP, PAS, ZAM		x	x					*Ríos 434* (QCA)	Schultes y Raffauf (1990)
Clidemia ostrina Gleason	CAR, ESM, MOR			x				So-é (Y)	*Kvist 40307* (QCA)	
Clidemia purpurea Pav. ex D. Don	ESM, GUA, RIO, MAN, PIC				x			Un ga lala jé tape (Y)	*Kvist y Asanza 40896* (QCA, QCNE)	
Clidemia septuplinervia Cogn.	ESM, RIO, MOR, NAP, PAS, PIC		x	x				Henda-pe-chi (Y)	*Kvist 40510* (QCA), *Ríos 357* (QCA)	
Clidemia sprucei Gleason	MOR, NAP, PAS		x					Amarun uchu (K), Ampár (U), Eweyiwe (H), Jempér (U), Sutulli (K), Teempe jari (U), Teempe-jari-Macuma, Uchan (K), Walinumba	*Asdall 8228* (QCA), *Kohn 1162* (QCA, QCNE), *Lewis et al. 13805* (QCA, QCNE), *Lewis et al. 14090* (QCA, QCNE), *Palacios 10254* (QCA, QCNE), *Ponce 226* (QCA), *Van Asdall 82-28* (QCA, QCNE)	Lescure et al. (1987)
Clidemia variifolia Wurdack	MOR, NAP, PAS		x					Piraña panga (K)	*Neill et al. 7723* (QCA, QCNE)	

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
Conostegia attenuata Triana	CAR, ESM			x				Picha guare (Q)	*Tipaz et al. 1354* (QCA, QCNE)	
Conostegia centronioides Markgr.	COT, ESM, RIO, MOR, PAS, PIC			x	x			Jendape mirogulachi, Ka-gen-tape (Y)	*Kvist y Asanza 40779* (QCA, QCNE), *Kvist, 40528* QCA	
Conostegia dentata Triana	CHI, ESM			x				Oñia-tapé-ban-vino -tapé-micharo- kola	*Barfod 48100* (QCA)	
Diplarpea paleacea Triana ex Cogn.	CAR, ESM			x				Hierba buena	*Kvist 48723* (QCA)	
Graffenrieda aff. *intermedia* Triana	ZAM		x				x	Ebenibe, Gonamonoyi, Evenyive, Tahualagi (todos H)		Cerón y Montalvo (1998)
Henriettella sp.	ESM, CAR, SUC, PAS, NAP, MOR	x								Ríos y Caballero (1997)
Leandra caquetana Sprague	MOR, NAP, PAS					x		Obata mëöyabo (H)	*Ríos 496* (QCA)	
Leandra caquetensis Gleason	LOJ, MOR, NAP, PAS, ZAM	x						Aéwáéñiwáé	*Oldeman 81* (QCA)	
Leandra granatensis Gleason	CAR, ESM, IMB, PIC			x				Quianchi (Y)	*Kvist 40326* (QCA)	
Leandra secunda (D. Don) Cogn.	MOR, NAP, PAS, SUC	x				x		Chanchák (A), Urkupayas (K)	*Jaramillo 10912* (QCA), *Lewis et al. 13906* (QCA, QCNE)	
Leandra subseriata	BOL, CAÑ, CAR,			x				Colca	*Cerón et al. 10384* (QCA,	

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
(Naudin) Cogn.	CHI, COT, IMB, PIC, TUN								QCNE)	
Loreya spruceana Benth. ex Triana	MOR, NAP						x	Chanchák (A), Payas (K), Quisa muyu yura (K), Titemenca (H)	*Irvine 128* (QCA), *Lewis et al. 13856* (QCA, QCNE)	Lescure et al. (1988)*, Schultes y Raffauf (1990)*
Maieta guianensis Aubl.	MOR, NAP, PAS, SUC			x			x	Chanchák chichi (A), Egïmö (H), Payas (K) , Putus panga (K), Shallipu (K), Uchan (K)	*Balslev 3016* (QCA), *Kohn 1211* (QCNE), *Lewis et al. 13899* (QCA, QCNE), *Neill et al. 8675* (QCA, QCNE), *Ríos 477* (QCA)	
Meriania tomentosa (Cogn.) Wurdack	AZU, BOL, CAÑ, CAR, CHI, COT, IMB, LOJ, MOR, NAP, PIC, TUN, ZAM						x	Hualicón cari	*Núñez et al. 23* (QCA, QCNE)	Cerón (1994, 1996)
Miconia aeruginosa Naudin	BOL, CAR, CHI, ORO, PIC					x		Colca, sagalita	*Cerón 12990* (QCA, QCNE)	
Miconia affinis DC.	IMB, NAP, SUC		x	x				Hagapania, Payanzo (K), Evenibe (H)	*Alarcón 34* (QCA)	Alarcón (1988)*, Cerón y Montalvo (1998), Lescure et al. (1987)*
Miconia asclepiadea Triana	AZU, BOL, CAR, MOR, NAP, PIC, TUN, ZAM	x							*s.c. 485* (QCA)	

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
Miconia aspergillaris (Bonpl.) Naudin	AZU, BOL, CAÑ, LOJ, MOR, PIC	x							*Jaramillo 3829* (QCNE)	
Miconia astroplocama Donn. Sm	ORO, RIO, MOR, NAP, PAS, PIC		x					Aó ne´e au (I)	*Vickers 207* (QCA)	Lescure et al. (1987), Vickers y Plowman (1984)
Miconia aureoides Cogn.	MOR, NAP, PAS, SUC		x				x	Evenyibe (H)		Cerón y Montalvo (1998)
Miconia barbinervis (Benth.) Triana	ESM, GUA, LOJ, RIO, MOR, NAP, PAS, PIC, SUC, TUN, ZAM			x				Hén-tapé (Y)	*Barfod et al. 48431* (QCA, QCNE)	
Miconia brachycalyx Triana	CAR, ESM, PIC		x					Chicharrón	*Palacios 5178* (QCA, QCNE)	
Miconia bracteolata (Bonpl.) DC.	AZU, CAÑ, CAR, CHI, COT, IMB, LOJ, MOR, NAP, PIC		x	x			x	Chilloyudo, Quijol	*Eriksen 59104* (QCNE), *Morán et al. 15* (QCA, QCNE), *Morán et al. 84* (QCA, QCNE)	
Miconia bubalina (D. Don) Naudin	GUA, MOR, NAP, PAS, SUC, ZAM		x	x			x	Ayamohue (H), Chiquitapayanzo, Ebenibe (H), Pishcu micuna muyu yura (K), Puca payas (K)	*Alarcón 35a* (QCA), *Aulestia y Nenquerei 1261* (QCA, QCNE), *Hurtado 2905* (QCA, QCNE), *Irvine 126a* (QCA)	Alarcón (1988)*, Cerón y Montalvo (1998), Lescure et al. (1987)*

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
Miconia caelata (Bonpl.) DC.	LOJ, ZAM		x					Cerrag (S)		Elleman (1991)
Miconia calvescens Shrank y Mart. ex DC.	RIO, MOR, NAP, PAS, SUC, TUN, ZAM						x	Pishcu micuna muyu yura (K)	*Irvine 102a* (QCA)	
Miconia cazaletii Wurdack	MOR, NAP						x	Yana muyo (K)	*Cerón 7850* (QCA, QCNE)	
Miconia centrodesma Naudin	ESM, MOR, NAP, PAS, ZAM						x	Payachic muyo (K)	*Hurtado et al. 2076* (QCA, QCNE)	
Miconia cercophora Wurdack	MOR, NAP, PAS, ZAM						x	Payachic (K)	*Hurtado y Alvarado 2128* (QCA, QCNE)	
Miconia corymbiformis Cogn.	AZU, BOL, CAÑ, CAR, COT, IMB, LOJ, NAP, PIC, SUC, TUN		x				x	Cerrag (S), Colca, Colca de hoja grande, Taruguita	*Cerón y Alarcón 12303* (QCA, QCNE), *Morán et al. 7* (QCA, QCNE), *Morán et al. 56* (QCA, QCNE)	Elleman (1991)
Miconia crocea (Desr.) Naud.	AZU, BOL, CAÑ, CAR, CHI, COT, IMB, LOJ, NAP, PIC, TUN	x		x			x	Amarillo, Colca	*Alvarez et al. 1198* (QCA, QCNE), *Ayala 2* (QCA), *Cerón et al. 932* (QCA, QCNE), *Cerón et al. 7134* (QCA, QCNE), *Cerón et al. 10436* (QCA, QCNE), *Cerón et al. 10718* (QCA, QCNE), *Cerón et al. 10841* (QCA, QCNE), *Cerón et al. 10997* (QCA, QCNE), *Cerón et al. 11*	Cerón (1994, 1996)
Miconia decurrens Cogn.	MOR, NAP, ZAM		x				x	Pischu-micuna muyu-yura (K)	*Irvine 127* (QCNE), *Irvine 127a* (QCA)	

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
Miconia erioclada Triana	ESM, MOR, NAP, PAS			x				Jedape nicha rocola (Y) jubiquichono tape (Y)	*Kvist 40569* (QCA, QCNE)	
Miconia floribunda (Bonpl.) DC.	NAP		x					Ebenyibe (H)		Cerón y Montalvo (1998)
Miconia goniostigma Triana	CAR, COT, ORO, ESM, RIO, MOR, NAP, PAS			x				Monte hierba	*Barfod 41500* (QCA, QCNE)	
Miconia gracilis Triana	CAR, ESM, PIC			x				Chiknul (Q), Hè.n-tapé (Y)	*Barfod 41033* (QCA), *Beck 1777* (QCA)	
Miconia latifolia (D. Don) Naudin	CAÑ, CAR, CHI, IMB, LOJ, MOR, NAP, PAS, PIC, TUN	x						Yamuchuchu (K)	*Cerón et al. 11777* (QCA, QCNE)	
Miconia ledifolia (DC.) Naudin	AZU, LOJ	x						Sierra (S)	*Eynden & Cueva 327* (QCA, QCNE)	Cueva (1997), Eynden (1997)
Miconia ligustrina (Sm.) Triana	AZU, CAR, COT, IMB, LOJ, MOR, NAP, PIC, SUC, TUN						x		*Morán et al. 58* (QCA, QCNE)	
Miconia lugonis Wurdack	ESM, MOR, NAP, PAS			x	x			A len tape (Y)	*Kvist 40769* (QCA)	
Miconia lutescens (Bonpl.) DC.	CAÑ, LOJ, ZAM	x					x	Taruma (S)	*Eynden 184a* (QCA)	Cueva (1997), Eynden (1997)
Miconia matthaei Naudin	NAP, SUC, ZAM		x				x	Gonomoroyi (H), Evenhibe (H)		Cerón y Montalvo (1998)

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
Miconia napoana Wurdack	NAP, PAS		x				x	Evengimo (H)		Cerón y Montalvo (1998)
Miconia nervosa (Sm.) Triana	ESM, IMB, MOR, NAP, PAS, PIC, SUC			x			x	Ewengimo, Heintapé (Y), Miñ-charro-kola-hambi-kèno-tape	*Barfod 41014* (QCA), *Barfod 48099* (QCA), *Miller 102* (QCA)	
Miconia nutans Donn. Sm.	CAR, IMB, MOR, NAP, PAS, TUN						x	Equive (H)		Cerón y Montalvo (1998)
Miconia obscura (Bonpl.) Naudin	AZU, LOJ, MOR, TUN, ZAM		x					Cerrag (S)	*Elleman 66671* (QCNE)	Elleman (1991)
Miconia ochracea Triana	BOL, CAR, IMB, NAP		x				x	Amarillo	*Tipaz 63* (QCA, QCNE)	
Miconia oraria Wurdack	CAR, ESM						x	Ma-sju-kè-mu-chi (Y), Mashu-kimu-chi	*Barfod 48216* (QCA), *Barfod 48339* (QCA)	
Miconia paleacea Cogn.	MOR, NAP, PAS		x	x				Caracha panga (K), Guala, Paijatsigi (K), Puca-paya-tsic-panga (K), Tacupayas (K)	*Bravo 42* (QCA), *Kohn 1090* (QCA, QCNE), *Kohn & Alvarado 1263* (QCA), *Neill 7730* (QCA, QCNE), *Palacios 10347* (QCA, QCNE)	Cerón (1994)
Miconia papillosa (Desr.) Naudin	CAR, IMB, LOJ, NAP, PIC, TUN, ZAM		x	x			x	Colca, Tostado de pajarito	*Morán & Paisano 114* (QCA, QCNE), *Tinajero 183, 184* (QCA)	
Miconia pilgeriana Ule	NAP, PAS, SUC, ZAM						x	Evenibe (H)		Cerón y Montalvo (1998)

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
Miconia procumbens (Gleason) Wurdack	MOR, NAP			x				Shishak (U)	*Warush RBAE 84* (QCA, QCNE)	
Miconia pustulata Naudin	AZU, BOL, CHI, COT, IMB, PIC		x				x	Amarillo, Angoterio	*Báez 35* (QCA), *Cerón et al. 6978* (QCA, QCNE), *Cuamacás & Gudiño 245* (QCA, QCNE)	Cerón (1994)
Miconia salicifolia (Bonpl. ex Naudin) Naudin	AZU, CAÑ, CAR, CHI, COT, IMB, LOJ, NAP, PIC, TUN		x				x	Chacla negra, Espinilla	*Cerón et al. 10867* (QCA, QCNE), *Cerón et al. 11069* (QCA, QCNE)	
Miconia splendens (Sw.) Griseb.	NAP, PAS, ZAM	x	x					Olla, Evenhibe (H)	*Cerón & Ayala 9995* (QCA, QCNE)	Cerón y Montalvo (1998)
Miconia subspicata Wurdack	MOR, NAP, PAS						x	Manzano blanco, San Juan	*Bravo 237* (QCA)	
Miconia theaezans (Bonpl.) Cong.	AZU, BOL, CAÑ, CAR, CHI, COT, ESM, LOJ, NAP, PAS, PIC, TUN, ZAM	x	x	x			x	Amarillo, Cerrac (S), Colca, Laichi, Sacha Colca	*Barfod 41495* (QCA, QCNE), *Cerón & Alarcón 12236* (QCA, QCNE), *Cuamacás et al. 217* (QCA, QCNE), *Ellemann 66506* (QCA), *Morán et al. 26* (QCA, QCNE), *Tipaz 7* (QCA, QCNE)	Cerón (1994, 1996), Elleman (1991)
Miconia tinifolia Naudin	BOL, CAR, IMB, LOJ, NAP, PIC, ZAM		x				x	Amarillo, Cerrag fino (S)	*Ellemann 66541* (QCA), *Tipaz 33* (QCA, QCNE)	Elleman (1991)

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
Miconia trinervia (Sw.) D. Don ex Loudon	CHI, ORO, ESM, MOR, NAP, PAS, SUC			x	x			Jedape mincharogola tape (Y)	*Kvist 40489* (QCA, QCNE)	
Miconia triplinervis Ruiz & Pav.	ESM, MOR, NAP, PAS, ZAM			x	x			Evengui (H), Llagaspanga, Uchan panga (K)	*Balslev 2933* (QCA), *Gudiño 1730* (QCA, QCNE)	Cerón y Montalvo (1998)
Miconia venulosa Wurdack	COT, ESM, MOR, NAP, PAS, PIC			x				Pengomo (Y)	*Kvist 40324* (QCA)	
Miconia versicolor Naudin	CHI, IMB, PIC	x					x	Morochillo		Cerón (1994, 1996)
Miconia zubenetana J.F. Macbr.	NAP, PAS			x				Biasek (K), Palo de agua	*Miller et al. 2370* (QCA, QCNE)	
Monochaetum hartwegianum Naudin	AZU, BOL, CAR, CHI, COT, IMB, PIC					x			*Cerón et al. 11002* (QCNE)	
Monochaetum lineatum (D. Don) Naudin	AZU, CAÑ, CAR, CHI, COT, IMB, LOJ, MOR, NAP, PAS, PIC, TUN, ZAM						x	Salapilla (S)	*Elleman 75407* (QCNE)	Elleman (1991)
Monolena primuliflora Hook.f.	CAR, COT, ESM, LOJ, MOR, NAP, PAS, PIC, TUN, ZAM	x		x				Apanguira, Aurutullo (K), Auru-tulla, Corazon panga, Jeen shiimujcu, Lyofasufsapa'cco, Lyunk (U), Nimon oñabo, Quenca	*Aulestia & Aulestia 1321* (QCA, QCNE), *Aulestia et al. 1456* (QCA, QCNE), *Barfod 41582* (QCA), *Cerón 186* (QCA), *Kohn 1156* (QCA, QCNE),	Cerón (1994), Kvist y Holm-Nielsen (1987), Schultes y Raffauf (1990)

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
								querentebin (H), Urti tullu (K)	*Lewis et al. 14198* (QCA, QCNE), *Macias & Asanza 19* (QCA, QCNE), *Neill 7728* (QCA), *Øllgaard 57359* (QCA), *Palacios 10291* (QCA)	
Mouriri grandiflora DC.	MOR, NAP, PAS, SUC	x					x	Sharima (U), Sharimiat	*Enynden et al. 914* (QCNE), *Palacios 6653* (QCA, QCNE)	Cerón (1994), Schultes y Raffauf (1990)
Mouriri nigra (DC.) Morley	MOR, NAP	x						Pagaramoncamo (H)	*Mendoza 201* (QCA)	Schultes y Raffauf (1990)
Mouriri oligantha Pilg.	MOR			x				Madera de pampil	*Miller et al. 2299* (QCA, QCNE)	
Ossaea bracteata Triana	CAR, PIC						x		*Buitrón 654* (QCA)	
Ossaea laxivenula Wurdack	CAR, ESM, IMB, MOR, PAS, PIC			x				Hein-tapé-chi (Y), O/.n-gala-hèn-tapé (Y)	*Barfod 41013* (QCA, QCNE), *Barfod 48173* (QCA), *Kvist 40364* (QCA)	
Ossaea micrantha (Sw.) Macfad. ex Cogn.	CAR, ORO, ESM, GUA, IMB, LOJ, RIO, MAN, MOR, NAP, PAS, PIC	x	x	x				Isah tape (O), Pichi ri chide (O), Tajasanene	*Hernández 111* (QCA), *Kvist 40048* (QCA), *Kvist 40162* (QCA)	
Ossaea quadrisulca (Naudin) Wurdack	MOR, NAP, PAS, ZAM	x						Caña agria, Fruto de conga, Yuturi muyu (K)	*Ríos 389, 390* (QCA)	
Ossaea robusta (Triana) Cogn.	CAR, ESM, MOR, NAP, PAS, PIC			x				Pengomo (Y)	*Kvist & Asanza 40324* (QCA, QCNE)	

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
Tessmannianthus heterostemon Markgr.	NAP, PAS		x					Evennive (H), Evenñimo (H)		Cerón y Montalvo (1998)
Tibouchina gleasoniana Wurdack	BOL, CAR, COT, IMB, PIC					x	x	Flor de mayo	*Cuamacás & Gudiño 181* (QCA, QCNE)	
Tibouchina grossa (L.f.) Cogn.	CAÑ, CAR, SUC					x			*Onore 628* (QCA)	
Tibouchina laxa (Desr.) Cogn.	AZU, BOL, CAÑ, CHI, ORO, LOJ, PIC, ZAM			x				Dom brin	*Cerón 13473* (QCA, QCNE)	
Tibouchina lepidota (Bonpl.) Baill.	AZU, CAR, CHI, IMB, LOJ, MOR, NAP, PIC, TUN, ZAM						x	Dumarin	*Ellemann 66543* (QCA)	
Tibouchina longifolia (Vahl) Baill.	BOL, CAR, CHI, COT, ORO, ESM, GUA, IMB, LOJ, RIO, MAN, MOR, NAP, PAS, PIC, TUN, ZAM						x	Kúkuj	*Morán & Paisano 79* (QCNE)	
Tibouchina mollis (Bonpl.) Cogn.	BOL, CAR, CHI, COT, ORO, IMB, LOJ, NAP, PIC, SUC, TUN		x			x	x	Flor de mayo	*Tinajero 190–195, 197* (QCA)	Cerón (1994, 1996)
Tibouchina oroensis Gleason	ORO, LOJ			x					*Palacios & Tirado 13013* (QCA, QCNE)	
Tococa guianensis Aubl.	ESM, MOR, NAP, PAS, SUC			x				Hallilumba, Payanshu (K), Jatunpayanshu (K)	*Alarcón 27* (QCA), *Blanc 96107* (QCA)	Alarcón (1988), Cerón y Montalvo (1998)*, Lescure et al. (1987)

Especie	Provincias	A	C	M	MR	O	R	Nombre vernáculo	Especímenes	Referencias
Tococa spadiciflora Triana	CAR, NAP, SUC						x		*Kvist 48701* (QCA)	
Tococa symphyandra (Triana) Cogn.	CAR, COT, ESM, MOR, NAP, PAS, TUN						x	Ouish (Q)	*Kvist 48725* (QCA)	
Triolena hirsuta (Benth.) Triana	AZU, ORO, ESM, GUA, PIC			x			x	Allipas payas (K), Cunua (K), Ho-horo-tapé (Y), Pini tape (O), Raca pies	*Alarcón 19508* (QCA), *Barfod 41084* (QCA), *Barfod 48032* (QCA), *Blanc 96553* (QCA), *Kvist 40094* (QCA)	Schultes y Raffauf (1990)
Triolena obliqua (Triana) Wurdack	CAR, NAP, PAS, PIC			x				Maipe	*Barfod 41418* (QCA), *Barfod 41642* (QCA), *Barfod 48807* (QCA), *Kvist 48714* (QCA)	
Triolena pedemontana Wurdack	COT, ESM, PIC			x				Contra	*Beck 1793* (QCA, QCNE)	
Triolena pluvialis (Wurdack) Wurdack	MOR, NAP, PAS, SUC			x				Cu'a shocongo, Cunua (K), Koshashi (F), Shashaki panga (K), Sutulli (K)	*Hurtado 2827* (QCNE), *Palacios 10344* (QCNE)	Alarcón (1988), Cerón (1994), Kvist y Holm-Nielsen (1987), Lescure et al. (1987), Schultes y Raffauf (1990), Vickers y Plowman (1984)
Triolena pustulata Triana	CHI, COT, GUA, RIO, MOR, PIC			x				Maape tape, Yahuar pallas (K)	*Blanc 9637* (QCA), *Yánez et al. 1418* (QCNE)	Schultes y Raffauf (1990)

Sucumbíos, TUN = Tungurahua, ZAM = Zamora Chinchipe. A = Achuar, F = Cofán, H = Huaorani, I = Siona-Secoya, K = Kichwa, O = Colorado, Q = Coaiquer, S = Saraguro, U = Shuar, Y = Cayapa. * = Especie citada bajo un sinónimo, mal escrita o no identificada.

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THE IDENTITY OF EAGLEWOOD (*GYRINOPS*, THYMELAEACEAE), A NEW ECONOMIC RESOURCE FOR PAPUA NEW GUINEA

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ABSTRACT

Gyrinops ledermannii (Thymelaeaceae) is identified as the tree involved in the eaglewood trade. Several taxa are currently being confused with *G. ledermannii* but the true eaglewood is readily distinguished by its floral characters.

TOK IGO PAS (MELANESIAN TOK PISIN)

Diwai ol i kolim *Gyrinops ledermannii* (Thymelaeaceae) long tok latin na igalwud or gaharu long tok malaia na nau em tu nem mipela i save long Papua New Guinea. *Gyrinops*, em nau i kamap wanpela diwai insait long maket bilong salim na baim dispela diwai. Pastaim sampela luksave long lif na flawa bilong dispela diwai ino bin kamap klia tumas. Tasol nau i gat wei bilong luksave long ol flawa na lif bilong trupela diwai igalwud.

INTRODUCTION

In recent years, a lucrative trade has emerged in the Hunstein subdistrict of East Sepik Province, involving a natural product commonly known as 'eaglewood' (Fig. 1). The newly established market is based on an arborescent species which accumulates aromatic oils in older wood. Demand for the fragrant wood can be likened to that for sandalwood, *Santalum* spp. (Santalaceae). However unlike sandalwood, the eaglewood essence appears to be a contingent response to injury or trauma, rather than a normal outcome of maturation. In its most desirable form, eaglewood becomes blackened by concentrated deposits of aromatic compounds, attracting prices of K800–1,000 per kg for the highest grades. Following separation of the oils, the fragrant extracts are currently used in the production of expensive incense and perfumes, for eventual purchase by Asian consumers.

Due to its recent appearance in commerce and unusually high value, eaglewood has become the focus of intense interest. Although the product is known primarily from lowland and low montane forest, there has been considerable uncertainty over the identity and number of species involved in the current trade. In an attempt to resolve the taxonomic issues, the eaglewood source areas near Ambunti township were visited by the authors in August 2001,

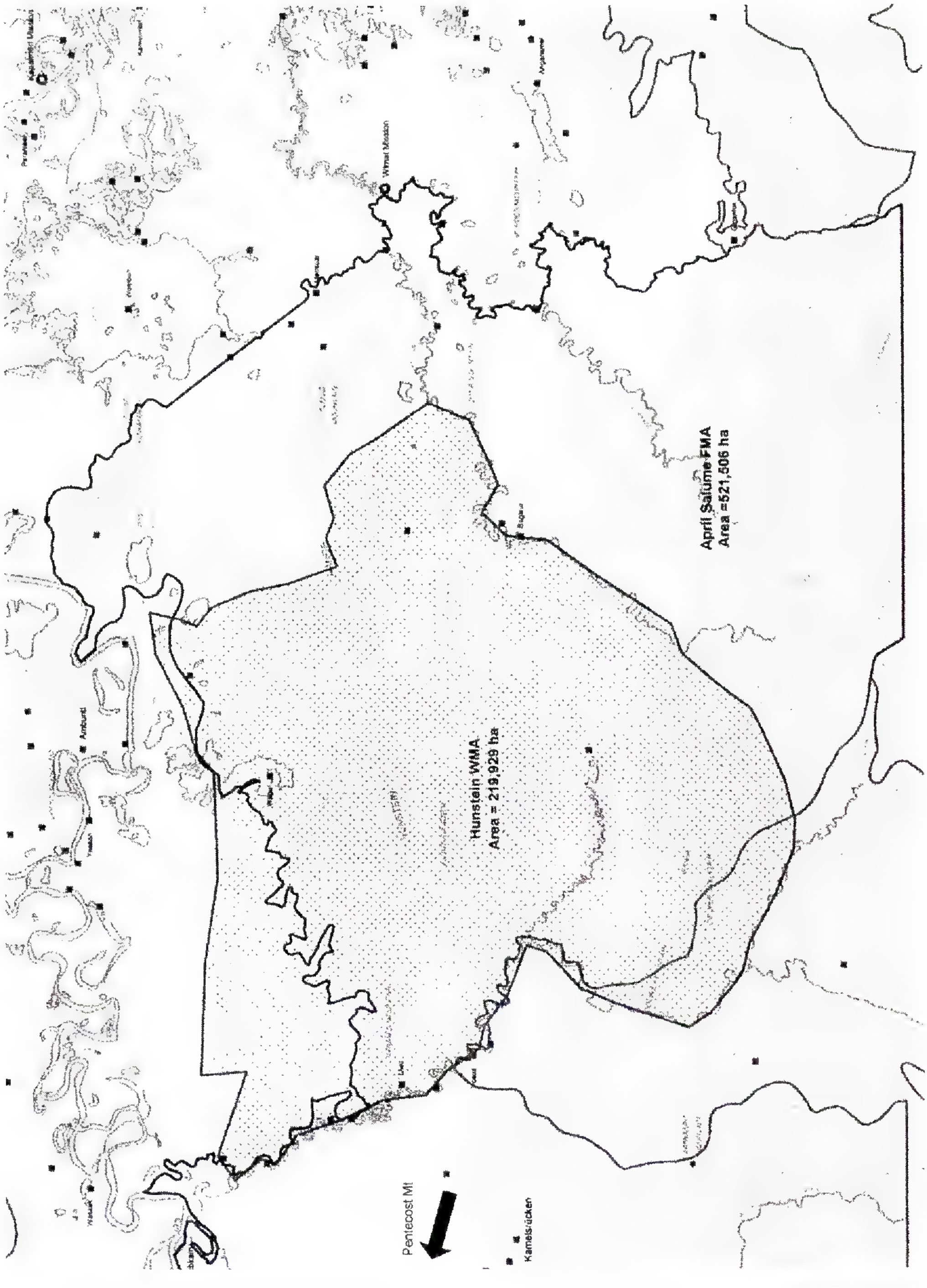


FIG. 1. Hunstein subdistrict, the principal geographic source for eaglewood. Most of the known populations are in the Hunstein WMA (dot stipling), but the distributional center for *Gyrinops ledermannii* probably lies further west. Gray shading indicates areas of closed canopy forest.

as part of a general floristic study of the upper Sepik. The following account presents the results of these investigations.[1]

TAXONOMY OF EAGLEWOOD

During the 1989 National Geographic Society expedition to Mt. Hunstein (cf. Bakker 1994; Sohmer et al. 1991), over 1,200 botanical specimens were obtained from areas where eaglewood is now harvested. Among the survey vouchers was *Takeuchi 4848* (A!, LAE!), collected from a tree described by village guides as having a fragrant black wood which could burn even when wet. This specimen was identified as *Gyrinops ledermannii* Domke on the original distribution (also confirmed in 1995, cf. annotation on the A duplicate), a species considered endemic to the upper Sepik and previously known with certainty only from the type gathering (*Ledermann 7401*; Pentecost Mt along the May River). The identification of the 1989 collection was facilitated by comparisons against two additional specimens obtained within the last 50 years, but the other reference materials have since disappeared from the Lae National Herbarium.

The Ledermann locality lies ca. 100 km WNW of the April River site designated as 'Kamelsrücken' (Samsai Mt) by early German explorers. Samsai villagers report that eaglewood is very common on the west-facing slopes of Kamelsrücken, in the direction of Pentecost Mt. Because the original specimen was taken from the May River, the local testimony implies that the distributional center for the species lies further to the west of existing production areas. The Hunstein populations are possibly only secondary occurrences.

Although Ledermann's type was lost in the 1943 destruction of Berlin Herbarium, the National Geographic survey voucher was unambiguously keyed to the given species using Ding Hou (1960). After eaglewood became a resource deserving of scrutiny, suspicion was thus directed to *Gyrinops* as the likely source for the new product.[2] However, in the absence of herbarium material specifically identified as eaglewood by local producers, it was difficult to be sure of the presumed correspondence. Especially as eaglewood was recently discovered in Jayapura (West Papua or Papua Barat, the former Irian Jaya), where it is there identified as *Aquilaria filaria* (Oken) Merr. (Thymelaeaceae), considerable confusion existed over the plant's identity.

A fertile collection taken during our Ambunti reconnaissance (*Towati & Golman 159*) was pointed out by village suppliers as an example of the tree harvested for the eaglewood trade. The Ambunti voucher includes both flowers and fruits, and its completeness leaves no room for doubt that *Gyrinops ledermannii* is the Hunstein eaglewood. In the Ambunti specimen, the pen-

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[1]The original submission of this manuscript was made to another journal in 2001, but subsequently withdrawn.

[2]A similar conclusion and an extensive discussion of eaglewood has been independently reported by Zich and Compton (2001) wnile this paper was in submission.

tamerous flowers have the same number of stamens as calyx lobes, each stamen also alternating with a fimbriate petaloid appendage. This clearly eliminates *Aquilaria* from consideration, because in that genus the number of stamens is twice that of the calyx lobes (Ding Hou 1960). *Aquilaria filaria* is otherwise very similar to *Gyrinops ledermannii*, particularly in their shared characteristic of loculicidal capsules that develop by rupturing through one side of the corolla tube. It is easy to get the two species confused unless the flowers are carefully examined. Reports of eaglewood being present in West Papua, and its identification as *Aquilaria filaria*, need to be reevaluated. *Aquilaria* has thus far been recorded in New Guinea only from the Vogelkop region, so its alleged presence at other West Papuan localities such as Jayapura is not unreasonable. Due to the similarities between the respective taxa, it is entirely plausible that *Aquilaria* represents another source for eaglewood. However photographs of the Jayapura provenance taken by M. Golman are more suggestive of *Gyrinops ledermannii* than of *Aquilaria filaria* (Figs. 2, 3).

Uncertainty over the identification of eaglewood is also evident among local villagers searching for the plant. Thymelaeaceae is a prominent family in the Hunstein flora, with very close similarities among its representatives. Within the existing source areas, *Phaleria coccinea* (Gaud.) F.v.M. (Thymelaeaceae) is the species most often mistaken for eaglewood. In superficial aspect its inflorescence is comparable to *Gyrinops*, and the leaves are also of similar appearance, particularly with respect to venation. As with other members of the family, *Phaleria coccinea* has an extremely strong inner bark which is often used in the construction of white bilums (i.e., local netbags used as carry-alls) noted for their soft texture.

Due to the black color of the branchlets, *Diospyros papuana* Val. (Ebenaceae) is also mistaken by villagers for eaglewood, even though the differences in morphological aspect are rather obvious. For example, unlike eaglewood the leaf venation in *D. papuana* is bifacially prominulous, and the fruits are indehiscent and large. The flowers are also unisexual and dioecious, rather than bisexual. Table 1 summarizes some of the salient distinctions between *Gyrinops ledermannii* and the plants with which it is presently confused.

In addition to the problems caused by similarities with other taxa, *G. ledermannii* is highly variable and can exhibit considerable difference in leaf size between individuals. The collection from the 1989 survey has lanceolate blades averaging 5.0 × 2.5 cm but the more recent material has elliptic leaves ca. 19.5 × 6.5 cm. Presumably these distinctions are at least partly under environmental control, especially in view of the wide range of substrates comprising eaglewood habitat (cf. Takeuchi & Golman 2002:63–64; this issue). The nondescript nature of the vegetative characters also discourages effective identification of sterile plants, thus adding to the confusion.



FIG. 2. Eaglewood from Jayapura. The numerous and obscure lateral veins are characteristic of both *Gyrinops ledermannii* and *Aquilaria filaria*. Photo by M. Golman, August, 2001.



FIG. 3. Flowering branchlet from the Jayapura population. The internal structure of the flower is critical to the proper identification of eaglewood. Photo by M. Golman, August, 2001.

TABLE 1. Comparative list of reproductive characters for *Gyrinops ledermannii* and the taxa with which it is confused in the field. Tokples names are provided with the village locality where the name originates. Voucher source: H&C = R. Hoogland and L. Craven, CSIRO survey from 1966; T – W. Takeuchi, Hunstein surveys from 1989, 1995.

Scientific name/Tokples name	Flower	Fruit
Gyrinops ledermannii Domke (Thymelaeaceae), may-hasei (Bugabugi, *T 15531*)	bisexual stamens same no. as calyx lobes; stamens included	small loculicidal capsule
Aquilaria filaria (Oken) Merr. (Thymelaeaceae), sp. not recorded from PNG	bisexual stamens 2 × no. of calyx lobes; stamens included	small loculicidal capsule
Phaleria coccinea (Gaud.) F.v.M. (Thymelaeaceae), wanyip or yaru (Wagu; *H&C 10371*); wonyip (Wagu; *H&C 10543*); winyap (Waskuk; *T 10193*)	bisexual stamens 2 × no. of calyx lobes; stamens exserted from floral tube	small drupe
Diospyros papuana Val. (Ebenaceae) manukway (Ambunti; *H&C 10214*); mankall (Waskuk; *T 10227*)	unisexual, dioecious stamens 3 4 × no. of calyx lobes; stamens included	large berry

DISCUSSION

Although the economic value of eaglewood affords the promise of substantial returns for stakeholders, high market prices clearly create incentives for overexploitation and eradication of natural populations. In order to ensure long-term viability of existing stocks, appropriate measures in resource management will eventually require enactment. However the present dearth of information on *Gyrinops ledermannii* will undoubtedly constrain its sustainable development. Even 90 years after its initial discovery, the plant remains poorly understood by botanical and forestry science. The demography, distribution, and ecology of *G. ledermannii* are unknown. This situation will require correction before eaglewood can be properly developed as an economic asset. There is also an obvious need for natural products research into the chemical principles which are responsible for eaglewood's desirable qualities. Depending on the nature of the resource, the species could conceivably serve as a valuable subject for silvicultural and natural products development.

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BOOK REVIEW

T.M. Antonio and S. Masi. 2001. **The Sunflower Family in the Upper Midwest: a Photographic Guide to the Asteraceae in Illinois, Indiana, Iowa, Michigan, Minnesota, and Wisconsin.** (ISBN 1-883362-11-3, hbk.). Indiana Academy of Science, Indianapolis, in collaboration with Chicago Botanic Garden, Glencoe, IL, U.S.A. $50.00, 419 pp, numerous color photos, maps, 7" × 10".

I love this book for the superlative photos and the detailed distribution maps—others may be more interested for the wealth of liberally referenced, genera- and species-specific information included in the species discussions. 150 species are treated, approximately one half of the family in the Upper Midwest (the region including, by definition, Illinois, Indiana, Iowa, Michigan, Minnesota, and Wisconsin). A full-page color photo for each species shows habit and habitat and smaller photos on the facing page provide details. A distribution map for each species gives county-level distribution for the entire region (Appendix VI give references from which the map data are derived). All Asteraceae species of the region are included in a key at the back of the book ("adapted largely from Swink and Wilhelm 1994"—Appendix II), but here is an example of photos good enough to serve for effective species-level identification, relegating the key to adjunct value (for example, compare among species of *Aster*, *Erigeron*, *Eupatorium*, *Lactuca*, and *Liatris*). The Introduction includes background information on recognition of the family, general principles of nomenclature and classification, and habitat and conservation, as well as "Comments on Distribution Maps" and "Comments on Photography" (technical and otherwise: "Waiting for the wind to die down in a midwestern prairie can seem to take an eternity").

In the context of general enthusiasm for this book, my 'technical' side can at least provide a wish-list of features toward a second edition:

(1) Overview. Synoptic list of all species of the area and distribution maps for all species – these could be added without accompanying photos and discussions.

(2) Nomenclature. How did the authors decide what generic name to use? Readers are referred to other floristic publications "for varying nomenclatural interpretations," but some generic concepts used in the book have been modified within the last decade or longer with varying degrees of acceptance: *Aster* (= *Doellingeria*, *Eurybia*, *Ionactis*, *Symphyotrichum*), *Cacalia* (= *Arnoglossum*), *Chrysopsis* (= *Heterotheca*), *Eupatorium* (– *Ageratina* and *Eupatorium* sensu stricto), *Gnaphalium* (= *Pseudognaphalium*), *Senecio* (– *Packera*) – not even synonyms are provided in the book. For other genera, listed synonyms give notice of potential taxonomic variance: *Chrysanthemum* (AKA *Leucanthemum*), *Kuhnia* (AKA *Brickellia*), *Hymenoxys* (AKA *Actinea*, but not *Tetraneuris* not listed), *Microseris* (AKA *Nothocalais*).

(3) Arrangement of species. The species are first arranged within four color classes—White or Green, White with Yellow Centers, Yellow or Yellow with Brown Centers, and Blue, Violet, Rose or Pink—then alphabetically by genus and species. I believe folks interested in Asteraceae, at almost all levels of botanical sophistication, could appreciate the value of placing all species of one genus together and arranging the genera by relationship rather than alphabetically.—*Guy L. Nesom, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

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VASCULAR PLANTS OF KONZA PRAIRIE BIOLOGICAL STATION: AN ANNOTATED CHECKLIST OF SPECIES IN A KANSAS TALLGRASS PRAIRIE

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ABSTRACT

The native and naturalized vascular plants of Konza Prairie Biological Station, a 3487-ha tallgrass prairie research site located in the Flint Hills of northeastern Kansas, are listed along with their primary habitat, relative abundance, flowering period, and life span. After more than 25 years of collections, the known vascular flora of Konza Prairie consists of 576 species, representing 336 genera and 96 families. Families with the most species are Poaceae (84), Asteraceae (79), Fabaceae (49), and Cyperaceae (33). Non-native species (n = 96) comprise 16.7% of the total flora. When categorized by life span, 64.6% of all species are perennials, 31.3% are annuals, and 4.2% are biennials. Species that are characteristically associated with a prairie habitat comprise 40.6% of the flora, followed by species in disturbed (22.4%), woodland (22.2%), and wetland (14.8%) habitats. In the prairie habitat, 16.2% of the species are grasses and 76.9% are herbaceous forbs. The C_4 photosynthetic pathway occurs in 59.5% of all grass species and in 70.8% of the annual grasses. The diversified habitats created by management and research activities on Konza Prairie provide a flora richness that is likely greater than that of any other area of comparable size in the Great Plains region.

KEY WORDS: Prairie Flora, Vascular Plant Survey, Biodiversity, Species Richness

RESUMEN

Las plantas vasculares indígenas y aclimatadas de la Estación Biológica de la Pradera Konza, un sitio de investigación en una pradera de pasto alto de 3487 hectáreas en el noreste de Kansas, se listan indicando su hábitat principal, abundancia relativa, periodo de floración y su longevidad. Tras más de 25 años de colectar, se han identificado 576 especies de flora vascular de la Pradera Konza, que representan 336 géneros y 96 familias. Las familias con mayor cantidad de especies son Poaceae (84), Asteraceae (79), Fabaceae (49) y Cyperaceae (33). Las especies no indígenas (n = 96) componen el 16.7% de la flora total. Cuando son clasificadas por su longevidad, 64.6% del total de especies son perennes, 31.3% anuales y 4.2% bienales. Las especies características de un hábitat de praderas componen el 40.6% de la flora total, seguidas por las de hábitat perturbado (22.4%), forestal (22.2%) y pantano (14.8%). La ruta fotosintética C_4 aparece en el 59.5% de las especies de pastos y en el 70.8% de los pastos anuales. Los hábitats diversificados que se han producido a través de actividades de administración e investigación en la Pradera Konza ofrecen una abundancia de flora que posiblemente sobrepasa cualquier otra área de tamaño comparable en esta región.

SITE OVERVIEW

Konza Prairie Biological Station is a 3487-ha tallgrass prairie located in the Flint Hills of northeastern Kansas (39° 05' N, 96° 35' W; Fig. 1). The Nature Conser-

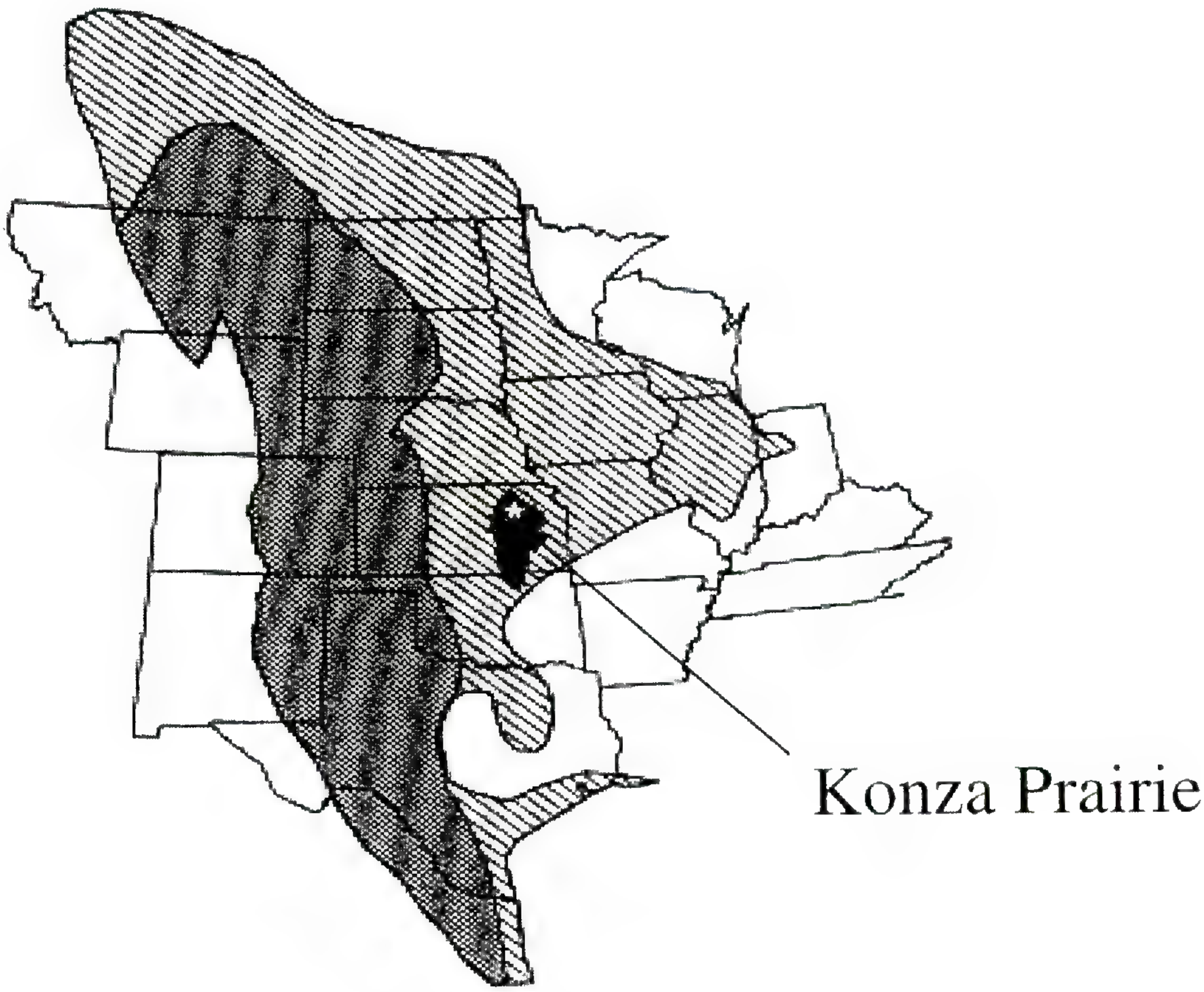


Fig. 1. Location of Konza Prairie in the flint hills of Kansas.

vancy initially purchased 371 ha of the site in 1971, followed by the remaining procurement in 1977. The preserve is managed for ecological research by the Division of Biology at Kansas State University. To study how fire and grazing affect the ecosystem, Konza Prairie is parceled into 52 watershed units that are burned at different frequencies and in different seasons, and are either ungrazed or grazed by large herbivores. Mowed fireguards or gravel roads separate the watersheds. Approximately 200 ha of agricultural land and abandoned brome fields are scattered throughout the site. The headquarters area consists of old homesteads with renovated buildings, a corral, and cultivated fields.

Topographically, the prairie landscape comprises upland plateaus, limestone hillsides, and fertile lowlands. The upland soils are relatively shallow, silty clay loams overlying limestone and shale layers (Udic Argiustolls and Lithic Haplustolls), whereas the lowland soils are deeper colluvial and alluvial deposits (Pachic Argiustolls). Two major creeks meander through the lowlands, but water flow is intermittent and dependent upon precipitation patterns. Permanent pools in the lower creek channels, localized springs, seeps, and several

small stock ponds constitute the wetland habitat. Gallery forests (bands of deciduous trees bordering the creeks and ravines) cover about 8.5% of the site.

Prairie vegetation is dominated by warm-season perennial grasses, with numerous interstitial forb species. Although the grassland flora consists primarily of tallgrass prairie plants, species that are characteristic of midgrass prairies thrive on the uplands and hillsides, and many shortgrass prairie species occur on the shallow, droughty sites.

For nearly 100 years, the site was a cattle ranch with both year-long and season-long grazing operations. After acquisition by The Nature Conservancy, Konza Prairie was not grazed by large herbivores until 1987, when a bison (*Bos bison*) herd was established in a 992-ha internal enclosure. Seasonal grazing by domestic cattle (*Bos taurus*) resumed in 1992 in 6 adjacent pastures (510 ha), although not all are grazed every year. The remainder of Konza Prairie is ungrazed by ungulates, except for a prolific white-tailed deer (*Odocoileus virginianus*) population.

Konza Prairie has a temperate continental climate, characterized by hot summers, cold winters, and moderately strong surface winds. Average annual precipitation is 835 mm, with 75% of this occurring in the April through September growing season. The average frost-free season lasts 180 days. Mean annual temperature is 13° C, with average minimum and maximum temperatures ranging from -3° C in January to 27° C in July. Elevations on Konza Prairie range from 320 to 444 m.

FLORISTIC EFFORTS

After a decade of collecting, 436 species of vascular plants (plus 5 varieties) were initially reported to occur on Konza Prairie (Freeman & Hulbert 1985), with another 27 species subsequently added (Freeman & Gibson 1987). Six years later, Kazmaier (unpublished pamphlet) listed 524 vascular plant species for Konza Prairie. Because of Konza Prairie's role as a benchmark tallgrass prairie, it is essential that the flora inventory and pertinent ecological synopsis of the species be current and readily accessible. With more than 70 new species discovered since Kazmaier's unpublished checklist, questionable validity of some previously listed species, and extensive nomenclatural revisions, an updated inventory of the Konza Prairie vegetation is necessary. Format for this flora follows standards proposed by Palmer et al. (1995). Voucher specimens are stored in the Kansas State University Herbarium (KSC).

ORGANIZATION OF THE CHECKLIST

The vascular plants known to occur spontaneously on Konza Prairie are arranged alphabetically by family, genus, and species within four groups: Pteridophyta (ferns and fern allies), Pinophyta (gymnosperms), Magnoliopsida

(dicots), and Liliopsida (monocots). Each entry includes scientific name, common name, relative abundance, primary habitat, flowering period, and life span (Appendix I). In addition, non-native species and the photosynthetic pathway of grass species are listed.

Nomenclature follows Kartesz (1999), although authority abbreviations conform to Brummitt and Powell (1992). A synonym is enclosed in brackets for those species that have been annotated recently or if the scientific name changed from that listed by Freeman and Hulbert (1985). Infraspecific taxa (subspecies and varieties) are not delineated, although naturally occurring hybrids are included.

The common name for each species was selected from regional sources (Anderson 1961; Bare 1979; Great Plains Flora Association 1986) to reflect customary usage for this area. Most species are identified with a single colloquial name, but alternatives are presented in a few instances. Structure and format of common names generally follow guidelines recommended by Kartesz and Thieret (1991).

The listed habitat indicates where each species is most likely found on Konza Prairie; however, it does not imply that the plant is restricted to that site. Many species occur at different densities in heterogeneous locations. Designated habitat categories for the Konza Prairie flora are:

Prairie—Open grassland that is subdivided by topographic position: uplands (clayey, cherty, or shallow soils on top of the hills), lowlands (deep bottom land soils), and slopes (rocky hillsides). Additionally, some species are listed as occurring predominantly in grazed or infrequently burned sites.

Woodland—Gallery forest and sites that are shaded by trees.

Wetland—Wet sites that include ponds, creeks, seeps, stock tanks, and mesic lowlands.

Disturbed—Sites where the soil has been disrupted, include trails, wallows, ditches, roadsides, homesteads, lawns, and cultivated fields.

Richness among the different plant habitats was estimated by assigning each species to one habitat. Because many species occur in a variety of habitats, assignment to a specific category may be debatable. However, the criterion for assigning species was based on which habitat the species is most characteristically associated with on Konza Prairie. Species that are found predominantly in disturbed sites were not considered prairie plants even if they appear sporadically in grazed or unburned prairie. Likewise, woodland species that migrate into unburned grassland were not grouped in the prairie habitat.

Relative abundance is an evaluation of how common and widespread a species is for the particular habitat, and is based on extensive field experience of the author. However, abundance of most annuals and some perennial species may fluctuate yearly in response to precipitation patterns and grazing or burning treatments. Descriptions of the five abundance classes are:

Abundant—Species is dominant or co-dominant in the habitat.
Common—Species is found easily in the particular habitat.
Occasional—Species occurs sporadically but is not difficult to find.
Infrequent—Species is relatively scarce and not easily found.
Rare—Species is seldom encountered or found only in specific locations.

The flowering period is when peak blooming normally occurs on Konza Prairie and often indicates when the species is most likely found. For vascular cryptogams, the dates represent spore formation. Flowering periods are based on field observations, herbarium specimens, and phenology records for this area.

Each species is classified by life span as either annual, biennial, or perennial. Non-herbaceous perennial plants were additionally subdivided into tree, shrub, and woody vine categories. Although some biennials and short-lived perennials may persist for only one year, designations were based on the expected longevity of the species for this area.

Grasses (Poaceae) are designated as either C_3 or C_4 species (Waller & Lewis 1979). The C_3 grasses are cool-season plants that initially produce a 3-carbon compound during photosynthesis and characteristically flower in May and June. The C_4 grasses are warm-season plants that initially produce a 4-carbon compound in the photosynthetic pathway and characteristically flower in July and August.

Species that were not present in this region before European settlement are considered introduced (Brooks 1986). Cultivated crops from the agricultural fields (e.g., wheat, oats, sorghum, corn, and soybean), and other non-naturalized annual species are not included in this checklist. However, exotic horticultural and ornamental species that were planted decades ago near the headquarters area and have subsequently persisted, are listed in Appendix II.

RESULTS AND DISCUSSION

The known vascular flora on Konza Prairie consists of 576 species, representing 336 genera and 96 families (Table 1; Appendix I). Families with the most species are Poaceae (84), Asteraceae (79), Fabaceae (49), and Cyperaceae (33). Forty families are represented by a single species. The most species-rich genera are *Carex* (17 species), *Polygonum* (12 species), *Symphyotrichum* (9 species), and *Asclepias* (9 species).

Twenty-three species from the last inventory (Kazmaier, unpublished pamphlet) are deleted from the present list because the specimens were misidentified (n = 8), had been reduced to synonymy (n = 4), or because there are no vouchers and no bona fide evidence of their presence on Konza Prairie. Most of the unsubstantiated species appeared in preliminary inventories (see Freeman & Hulbert 1985), and their unverified presence was subsequently perpetuated. Taxonomic revisions of Kazmaier's unpublished checklist also transferred 55 species into different genera and changed the specific epithet of 19 species.

TABLE 1. Summary of vascular plant families, genera, and species on Konza Prairie.

Taxonomic group	Families	Genera	Species		
			Native	Introduced	Total
Pteridophyta	4	6	6	0	6
Pinophyta	1	1	1	0	1
Magnoliophyta:					
Magnoliopsida	76	254	349	73	422
Liliopsida	15	75	124	23	147
Total	96	336	480	96	576

When species are categorized to one predominant habitat, 40.6% of Konza Prairie plants are characteristically associated with prairie grassland, followed by disturbed (22.4%), woodland (22.2%), and wetland (14.8%) habitats (Table 2). In the prairie habitat, 16.2% of the species are grasses and 76.9% are herbaceous forbs. Only seven woody species are characteristically associated with the prairie habitat; but without frequent fire, many woodland species invade and proliferate. Species richness is lowest in wetland sites, but these areas are the smallest and most fragmented habitats on Konza Prairie.

When partitioned into life span categories, 316 species (54.9%) are herbaceous perennials, 56 species (9.7%) are woody perennials, 180 species (31.3%) are annuals, and 24 species (4.2%) are biennials. Within the prairie habitat, 76.1% of the species are perennials, 20.9% are annuals, and 3.0% are biennials. In comparison, 23.3% of the species in disturbed sites are perennials, 69.0% are annuals, and 7.8% are biennials.

Non-native species (n = 96) account for 16.7% of the total flora. Families with the most introduced species are Poaceae (21), Brassicaceae (13), Fabaceae (9), and Asteraceae (8). Annuals and biennials comprise 59.4% of all introduced species, compared to 30.8% of the native flora (Table 3). The highest density of exotics is in the headquarters area where many species were planted intentionally or are cosmopolitan weeds. Most introduced species are either restricted to disturbed soils or are weak competitors in native prairie. However, some invasive species are capable of displacing native vegetation. Because the aggressiveness of four exotic species (*Bothriochloa bladhii*, *Bothriochloa ischaemum*, *Carduus nutans*, and *Lespedeza cuneata*) potentially threatens the integrity of tallgrass prairie, they have been specifically targeted for eradication.

The C_4 photosynthetic pathway occurs in 59.5% for all grass species and in 65.1% of the native grasses. Of the 24 annual grasses that occur on Konza Prairie, 17 species (70.8%) use the C_4 photosynthetic pathway. Most dicotyledons use the C_3 photosynthetic pathway, but 14 species representing five genera (*Amaranthus*, *Bassia*, *Chamaesyce*, *Portulaca*, and *Tribulus*) have C_4 photosyn-

TABLE 2. The number of vascular plant species within taxonomic groups that are characteristically associated with different habitats on Konza Prairie.

Taxonomic group	Prairie	Disturbance	Woodland	Wetland
Pteridophyta	0	0	5	1
Pinophyta	0	0	1	0
Magnoliophyta:				
Magnoliopsida	178	98	102	45
Liliopsida	56	31	20	39
Total numbers	234	129	128	85
Percent	40.6%	22.4%	22.2%	14.8%

TABLE 3. The number and percent of native and introduced species within different life form categories on Konza Prairie.

	Native Species		Introduced Species	
Life form	Number	%	Number	%
Total annuals	134	27.9	47	49.0
Annual grasses	16	3.3	8	8.3
Annual dicot forbs	111	23.1	39	40.6
Annual monocots	7	1.5	0	0
Biennial dicots	14	2.9	10	10.4
Total perennials	332	69.2	39	40.6
Perennial grasses	47	9.8	13	13.5
Perennial dicot forbs	176	36.8	18	18.8
Perennial monocots	53	11.0	2	2.1
Woody	50	10.4	6	6.3
Vascular cryptogams	6	1.3	0	0
Totals	480		96	

thesis (Downton 1975). All of the Konza Prairie forb species that utilize the C_4 photosynthetic pathway are annuals.

Although field collections of Konza Prairie flora have been ongoing for more than 25 years, the compilation of vascular plants will continue to be dynamic. New immigrants, ephemeral annuals that fluctuate with precipitation patterns, and superficially similar species will undoubtedly be found in subsequent years. Species also will disappear. Some species have not been observed on Konza Prairie for more than 10 years and may be extirpated. Other species occur in a single locale or consist of only a few plants. Few areas of tallgrass prairie have been surveyed as intensively as Konza Prairie, and the diversified habitats created by management and research activities provide a flora richness that is likely greater than any other area of comparable size in the Great Plains region.

APPENDIX 1
Annotated Checklist of Species for Konza Prairie

PTERIDOPHYTA – Vascular Cryptogams

DRYOPTERIDACEAE – Wood fern family

Woodsia obtusa (Spreng.) Torr.; blunt-lobed cliff fern; rare on shaded limestone outcrops; Jul; perennial.

EQUISETACEAE – Horsetail family

Equisetum laevigatum Braun; smooth scouring rush; infrequent in wet sites; May–Jun; perennial.

OPHIOGLOSSACEAE – Adder's-tongue family

Botrychium virginianum (L.) Sw.; rattlesnake fern; occasional in woodlands; May–Jun; perennial.

Ophioglossum engelmannii Prantl; adder's tongue; rare in woody lowlands; Apr–Jun; perennial.

PTERIDACEAE – Maidenhair fern family

Argyrochosma dealbata (Pursh) Windham; [*Notholaena dealbata*]; false cloak fern; rare on shaded limestone outcrops; Jun; perennial.

Pellaea glabella Mett. ex Kuhn; smooth cliff brake; rare on shaded limestone outcrops; May Jun; perennial.

DIVISION PINOPHYTA – Gymnosperms

CUPRESSACEAE – Cypress family

Juniperus virginiana L.; red-cedar; occasional in woodlands and unburned prairie; Mar–Apr; evergreen tree.

DIVISION MAGNOLIOPHYTA – Angiosperms
Class Magnoliopsida – Dicots

ACANTHACEAE – Acanthus family

Ruellia humilis Nutt.; fringe-leaf ruellia; common on all prairie sites; Jun Aug; perennial.

Ruellia strepens L.; limestone ruellia; occasional in woodlands; May -Sep; perennial.

ACERACEAE – Maple family

Acer negundo L.; boxelder; occasional in woodlands; Apr; tree.

AMARANTHACEAE – Pigweed family

Amaranthus blitoides Watson; [*Amaranthus graecizans*]; prostrate pigweed; common in disturbed sites and along roads; Jun–Sep; annual.

Amaranthus palmeri Watson; Palmer's pigweed; infrequent in disturbed sites; Jul -Oct; annual.

Amaranthus retroflexus L.; rough pigweed; infrequent in cultivated fields and disturbed lowlands; Jul Oct; introduced annual.

Amaranthus rudis Sauer; water-hemp; rare in wet sites; Jul–Oct; annual.

ANACARDIACEAE – Cashew family

Rhus aromatica Aiton; aromatic sumac; infrequent on uplands and lowlands; Apr–May; shrub.

Rhus glabra L.; smooth sumac; common on shallow uplands and slopes; May–Jun; shrub.

Toxicodendron radicans (L.) Kuntze; poison-ivy; common in woodlands; May–Jun; woody vine.

ANNONACEAE – Custard-apple family

Asimina triloba (L.) Dunal; pawpaw; rare in woodlands and along creeks; Apr–May; tree.

APIACEAE – Parsley family

Chaerophyllum procumbens (L.) Crantz; spreading chervil; infrequent at woodland edges and in unburned prairie; May Jun; annual.

Chaerophyllum tainturieri Hook.; erect chervil; infrequent at woodland edges; May–Jun; annual.

Conium maculatum L.; poison-hemlock; infrequent at woodland edges and in disturbed sites; May -Jun; introduced biennial

Lomatium foeniculaceum (Nutt.) Coult. & Rose; carrot-leaf lomatium; common on shallow uplands and slopes; Apr–May; perennial.

Osmorhiza longistylis (Torr.) DC.; long style sweet cicely rare in woodlands; May; perennia

Sanicula canadensis L.; Canadian sanicle; occasional in woodlands; Jul–Sep; biennial.

Spermolepis inermis (Nutt. ex DC.) Mathias & Constance; scaleseed; occasional on uplands and slopes; Jun; annual.

Torilis arvensis (Huds.) Link; hedge-parsley; infrequent at woodland edges and in unburned prairie; Jun–Jul; introduced annual.

Zizia aurea (L.) Koch; golden alexanders; occasiona in woodlands; May Jun; perennial.

APOCYNACEAE – Dogbane family

Apocynum cannabinum L.; hemp dogbane; occasional on lowlands; Jun–Jul; perennial.

ASCLEPIADACEAE – Milkweed family

Asclepias lanuginosa Nutt.; woolly milkweed; rare on grazed uplands; May; perennial.

Asclepias speciosa Torr.; showy milkweed; rare on uplands and lowlands; Jun; perennial.

Asclepias stenophylla A. Gray; narrow-leaf milkweed; occasional on uplands and lowlands; Jun–Jul; perennial.

Asclepias sullivantii Engelm. ex A. Gray; smooth milkweed; occasional on lowlands; Jun; perennial.

Asclepias syriaca L.; common milkweed; occasional on lowlands; Jun; perennial.

Asclepias tuberosa L.; butterfly milkweed; occasional on uplands and lowlands; Jun–Jul; perennial.

Asclepias verticillata L.; whorled milkweed; common on all prairie sites; Jun–Sep; perennial.

Asclepias viridiflora Raf.; green milkweed; occasional on uplands and slopes; Jun–Jul; perennial.

Asclepias viridis Walter; spider milkweed; common on all prairie sites; May–Jun; perennial.

Cynanchum laeve (Michx.) Pers.; climbing milkweed; infrequent at woodland edges and in disturbed lowlands; Jul–Sep; perennial.

ASTERACEAE – Sunflower family

Achillea millefolium L.; western yarrow; common on all prairie sites; May–Jun; perennial.

Ageratina altissima (L.) King & Rob.; [*Eupatorium rugosum*]; white snakeroot; common in woodlands; Aug–Oct; perennial.

Ambrosia artemisiifolia L.; annual ragweed; occasional in disturbed sites; Jul–Oct; annual.

Ambrosia psilostachya DC.; western ragweed; abundant on all prairie sites; Jul–Oct; perennial.

Ambrosia trifida L.; giant ragweed; occasional in disturbed sites and at woodland edges; Jul–Oct; annual.

Amphiachyris dracunculoides (DC.) Nutt.; [*Gutierrezia dracunculoides*]; annual broomweed; infrequent in disturbed sites; Aug–Oct; annual.

Antennaria neglecta Greene; field pussytoes; common on uplands; Apr–May; perennial.

Arctium minus Bernh.; burdock; infrequent in woodlands and shaded disturbed sites; Jul–Sep; introduced biennial.

Arnoglossum plantagineum Raf.; [*Cacalia plantaginea*]; tuberous indian-plantain; occasional on uplands and lowlands; Jun–Jul; perennial.

Artemisia ludoviciana Nutt.; Louisiana sagewort; common on all prairie sites; Aug–Sep; perennial.

Bidens aristosa (Michx.) Britton; [*Bidens polylepis*]; coreopsis beggar-ticks; infrequent in wet sites; Sep–Oct; annual.

Bidens bipinnata L.; Spanish needles; rare in wet sites; Sep–Oct; annual.

Bidens cernua L.; nodding beggar-ticks; infrequent in wet sites; Sep–Oct; annual.

Bidens frondosa L.; devil's beggar-ticks; occasional in wet sites; Sep–Oct; annual.

Brickellia eupatorioides (L.) Shinners; [*Kuhnia eupatorioides*]; false-boneset; common on uplands and slopes; Aug–Sep; perennial.

Carduus nutans L.; musk thistle; infrequent on lowlands and in disturbed sites; May–Jun; introduced biennial.

Cirsium altissimum (L.) Spreng.; tall thistle; common in unburned lowlands; Aug–Sep; biennial.

Cirsium undulatum (Nutt.) Spreng.; wavy-leaf thistle; common on uplands and slopes; Jun–Jul; perennial.

Cirsium vulgare (Savi) Ten.; bull thistle; rare in disturbed sites; Jun–Sep; introduced biennial.

Conyza canadensis (L.) Cronquist; Canadian horseweed; common in disturbed sites; Jul–Sep; annual.

Conyza ramosissima Cronquist; spreading horseweed; rare in disturbed sites; Jul–Sep; annual.

Dyssodia papposa (Vent.) Hitchc.; fetid-marigold, prairie dogweed; occasional along roads; Jul–Oct; annual.

Echinacea angustifolia DC.; black-sampson echinacea; common on slopes and rocky prairie; Jun; perennial.

Eclipta prostrata (L.) L.; yerba-de-tajo; rare along creeks; Jul–Sep; annual.

Erechtites hieraciifolia (L.) Raf. ex DC.; American burnweed; infrequent at woodland edges and along creeks; Aug–Sep; annual.

Erigeron annuus (L.) Pers.; annual fleabane; occasional in disturbed lowlands; May–Jun; annual.

Erigeron philadelphicus L.; Philadelphia fleabane; infrequent in mesic lowlands; Apr–Jun; biennial.

Erigeron strigosus Muhl. ex Willd.; daisy fleabane; common on uplands and in disturbed sites; May–Jun; annual.

Eupatorium altissimum L.; tall joe-pye weed; occasional on lowlands; Aug–Sep; perennial.

Euthamia gymnospermoides Greene; sticky euthamia; infrequent on lowlands; Sep–Oct; perennial.

Grindelia squarrosa (Pursh) Dunal; curly-cup gumweed; common in disturbed sites and along roads; Aug–Oct; biennial.

Helianthus annuus L.; common sunflower; common in ditches and disturbed sites; Jul–Oct; annual.

Helianthus hirsutus Raf.; hairy sunflower; common at woodland edges; Jul–Oct; perennial.

Helianthus maximilianii Schrad.; Maximilian's sunflower; occasional on uplands and slopes; Aug–Oct; perennial.

Helianthus pauciflorus Nutt.; [*Helianthus rigidus*]; stiff sunflower; occasional on uplands; Jul–Sep; perennial.

Helianthus petiolaris Nutt.; plains sunflower; rare in disturbed sites; Jul–Sep; annual.

Helianthus tuberosus L.; Jerusalem artichoke; common at woodland edges; Aug–Oct; perennial.

Heliopsis helianthoides (L.) Sweet; rough heliopsis; infrequent on lowlands; Jul–Sep; perennial.

Heterotheca canescens (DC.) Shinners; [*Chrysopsis canescens*]; golden aster; rare on uplands; Aug–Sep; perennial.

Hieracium longipilum Torr.; long-beard hawkweed; occasional on uplands; Jul; perennial.

Hymenopappus scabiosaeus L'Her.; white-bract hymenopappus, old plainsman; occasional on shallow uplands and slopes; May–Jun; biennial.

Iva annua L.; annual sumpweed; rare in ditches and mesic disturbed sites; Aug–Oct; annual.

Krigia cespitosa (Raf.) Chambers; dwarf-dandelion; infrequent in mesic uplands and lowlands; May–Jun; annual.

Lactuca canadensis L.; Canadian lettuce; infrequent at woodland edges; Jul–Sep; biennial.

Lactuca ludoviciana (Nutt.) Riddell; Louisiana lettuce; occasional in unburned prairie; Jul–Sep; biennial.

Lactuca saligna L.; willow leaf lettuce; infrequent at woodland edges and in disturbed sites; Jul–Sep; introduced annual.

Lactuca serriola L.; prickly lettuce; occasional in unburned prairie and disturbed sites; Jul–Sep; introduced annual.

Liatris aspera Michx.; button gayfeather; infrequent on uplands and rocky prairie; Aug–Sep; perennial.

Liatris mucronata DC.; eastern dotted gayfeather; infrequent on uplands; Aug–Sep; perennial.

Liatris punctata Hook.; western dotted gayfeather; common on shallow uplands and rocky prairie; Aug–Sep; perennial.

Nothocalais cuspidata (Pursh) Greene; [*Microseris cuspidata*]; wavy leaf false dandelion; infrequent on uplands and slopes; Apr–May; perennial.

Oligoneuron rigidum (L.) Small; [*Solidago rigida*]; stiff goldenrod; occasional on lowlands; Aug–Oct; perennial.

Packera plattensis (Nutt.) Weber & Löve; [*Senecio plattensis*]; prairie groundsel; common on uplands; Apr–May; biennial.

Pseudognaphalium obtusifolium (L.) Hilliard & Burtt; [*Gnaphalium obtusifolium*]; fragrant cudweed; infrequent on uplands and lowlands; Sep–Oct; annual.

Ratibida columnifera (Nutt.) Wooton & Standl.; upright prairie-coneflower; common on uplands and along roads; Jun–Jul; perennial.

Rudbeckia hirta L.; black-eyed susan; infrequent on owlands; Jun–Jul; biennial.

Silphium integrifolium Michx.; whole-leaf rosinweed; infrequent on lowlands; Jul–Aug; perennial.

Silphium laciniatum L.; compassplant; occasional on lowlands; Jul–Aug; perennial.

Solidago canadensis L.; tall goldenrod, Canadian goldenrod; common on lowlands; Aug–Oct; perennial.

Solidago gigantea Aiton; late goldenrod; infrequent in mesic lowlands; Sep–Oct; perennial.

Solidago missouriensis Nutt.; Missouri goldenrod; common on all prairie sites; Aug–Oct; perennial.

Solidago mollis Bartl.; ashy goldenrod; rare on uplands; Aug–Sep; perennial.
Solidago petiolaris Aiton; downy goldenrod; infrequent on rocky prairie; Sep–Oct; perennial.
Solidago speciosa Nutt.; showy-wand goldenrod; infrequent on uplands; Sep–Oct; perennial.
Sonchus asper (L.) Hill; prickly sow-thistle; infrequent in disturbed sites; Jun–Oct; introduced annual.
Symphyotrichum drummondii (Lindl.) Nesom; [*Aster drummondii*]; Drummond's aster; common in woodlands; Sep–Oct; perennial.
Symphyotrichum ericoides (L.) Nesom; [*Aster ericoides*]; heath aster; abundant on all prairie sites; Sep–Oct; perennial.
Symphyotrichum laeve (L.) Löve; [*Aster laevis*]; smooth aster; occasional on uplands and slopes; Sep–Oct; perennial.
Symphyotrichum lanceolatum (Willd.) Nesom; [*Aster simplex*]; panicled aster; occasional on lowlands; Sep–Oct; perennial.
Symphyotrichum oblongifolium (Nutt.) Nesom; [*Aster oblongifolius*]; aromatic aster; common on uplands; Sep–Oct; perennial.
Symphyotrichum oolentangiense (Riddell) Nesom [*Aster oolentangiensis*]; azure aster; rare on lowlands; Sep–Oct; perennial.
Symphyotrichum pilosum (Willd.) Nesom; [*Aster pilosus*]; hairy aster; infrequent on lowlands and in abandoned brome fields; Sep–Oct; perennial.
Symphyotrichum sericeum (Vent.) Nesom; [*Aster sericeus*]; silky aster; occasional on uplands and slopes; Aug–Oct; perennial.
Symphyotrichum subulatum (Michx.) Nesom; [*Aster subulatus*]; saltmarsh aster; infrequent in ditches and wet sites; Sep–Oct; annual.
Taraxacum officinale Weber ex Wigg.; dandelion; occasional around headquarters; Mar–Oct; introduced perennial.
Tragopogon dubius Scop.; western salsify, goat's-beard; infrequent in ditches and disturbed sites; May–Jun; introduced biennial.
Verbesina alternifolia (L.) Britton ex Kearney; wing-stem; common in woodlands; Aug–Oct; perennial.
Vernonia baldwinii Torr.; western ironweed; common on all prairie sites; Jul–Sep; perennial.
Xanthium strumarium L.; cocklebur; infrequent in ditches and disturbed sites; Jul–Oct; annual.

BETULACEAE – Birch family

Ostrya virginiana (Mill.) Koch; hop-hornbeam; rare on wooded slopes; Apr; tree.

BIGNONIACEAE – Bignonia family

Campsis radicans (L.) Seem. ex Bureau; trumpet creeper; infrequent in woodlands; Jun–Aug; woody vine.

BORAGINACEAE – Borage family

Buglossoides arvensis (L.) Johnst.; [*Lithospermum arvense*]; corn gromwell; infrequent in ditches and disturbed sites; Apr–May; introduced annual.
Cynoglossum officinale L.; hound's-tongue; rare in woodlands; Jun–Jul; introduced biennial.
Hackelia virginiana (L.) Johnst.; Virginia stickseed; occasional in woodlands; Jul–Aug; biennial.
Lithospermum canescens (Michx.) Lehm.; hoary gromwell; rare on uplands and slopes; May; perennial.
Lithospermum incisum Lehm.; narrow-leaf gromwell, fringed puccoon; occasional on uplands and slopes; Apr–May; perennial.
Myosotis verna Nutt.; Virginia forget-me-not; infrequent on uplands; May; annual.
Onosmodium molle Michx.; western marbleseed; infrequent on uplands and slopes; Jun–Jul; perennial.

BRASSICACEAE – Mustard family

Alliaria petiolata (Bieb.) Cavara & Grande; garlic-mustard; common in woodlands; Apr–May; introduced biennial.
Arabis hirsuta (L.) Scop.; hairy rockcress; rare in abandoned brome fields and disturbed sites; May–Jun; biennial.
Barbarea vulgaris Br.; wintercress; rare in ditches and disturbed sites; Apr–May; introduced perennial.
Camelina microcarpa DC.; little-pod false-flax; infrequent along roads and in disturbed sites; Apr -May; introduced annual.
Capsella bursa-pastoris (L.) Medik.; shepherd's-purse; occasional in disturbed sites; Apr–May; introduced annual.
Cardamine concatenata (Michx.) Schwarz; [*Dentaria laciniata*]; cut-leaf toothwort; rare in woodlands; Apr–May; perennial.
Cardaria draba (L.) Desv.; hoary cress; rare in disturbed sites; May; introduced perennial.
Chorispora tenella (Pallas) DC.; blue-mustard;

infrequent in disturbed sites; Apr–May; introduced annual.

Descurainia pinnata (Walter) Britton; pinnate tansy-mustard; occasional in disturbed sites; May–Jun; annual.

Descurainia sophia (L.) Webb ex Prantl; flixweed tansy-mustard; rare in disturbed sites; May–Jun; introduced annual.

Draba cuneifolia Nutt. ex Torr. & A. Gray; wedge leaf draba; occasional on shallow and rocky sites; Apr May; annual.

Draba reptans (Lam.) Fernald; white whitlow wort; occasional on shallow uplands and slopes; Apr–May; annual.

Erysimum repandum L.; bushy wallflower; infrequent in ditches and disturbed sites; Apr - May; introduced annual.

Hesperis matronalis L.; dame's rocket; rare around headquarters; Apr May; introduced perennial.

Lepidium densiflorum Schrad.; common pepperweed; common on uplands and in disturbed sites; Apr Jun; introduced annual.

Lepidium oblongum Small; branched pepperweed; occasional in disturbed sites and along roads; Apr Jun; annual.

Lepidium virginicum L.; Virginia pepperweed; common in disturbed sites and along roads; Apr–Jun; annual.

Microthlaspi perfoliatum (L.) Mey.; [*Thlaspi perfoliatum*]; perfoliate pennycress; rare around headquarters; Apr; introduced annual.

Rorippa nasturtium aquaticum (L.) Hayek; [*Nasturtium officinale*]; watercress; occasional in wet sites; May–Jul; introduced perennial.

Rorippa palustris (L.) Besser; bog yellowcress; rare in wet sites; May–Jul; annual.

Rorippa sessiliflora (Nutt.) Hitchc.; stalkless yellow cress; rare in wet sites; May–Jul; annual.

Rorippa sinuata (Nutt.) Hitchc.; spreading yellow cress; infrequent along creeks; May Jun; perennial.

Thlaspi arvense L.; field pennycress; occasional in disturbed sites; Apr May; introduced annual.

CACTACEAE – Cactus family

Escobaria missouriensis (Sweet) Hunt.; [*Coryphantha missouriensis*]; nipple cactus; infrequent on shallow uplands; Apr–May; perennial.

Opuntia macrorhiza Engelm.; plains pricklypear; infrequent on shallow uplands; May–Jun; perennial.

CAMPANULACEAE – Bell-flower family

Campanulastrum americanum (L.) Small; [*Campanula americana*]; American bellflower; infrequent in wet sites; Jul–Sep; annual.

Lobelia cardinalis L.; red cardinal flower; rare in wet sites; Aug–Oct; perennial.

Lobelia siphilitica L.; blue cardinal-flower; infrequent in wet sites; Aug–Oct; perennial.

Triodanis leptocarpa (Nutt.) Nieuwl.; slimpod Venus' looking-glass; infrequent on uplands and lowlands; May–Jun; annual.

Triodanis perfoliata (L.) Nieuwl.; clasping Venus'-looking-glass; occasional on uplands and lowlands; May–Jun; annual.

CANNABACEAE – Hemp family

Cannabis sativa L.; marijuana, hemp; occasional in ditches, at woodland edges, and around headquarters; Jul–Sep; introduced annual.

CAPPARACEAE – Caper family

Polanisia dodecandra (L.) DC.; clammyweed; infrequent in disturbed sites and on slopes; Jul–Sep; annual.

CAPRIFOLIACEAE – Honeysuckle family

Lonicera maackii (Rupr.) Maxim.; Amur honeysuckle; rare in shaded sites near headquarters; May; introduced shrub.

Sambucus nigra L.; [*Sambucus canadensis*]; American elderberry; infrequent in woodlands; Jun–Jul; shrub.

Symphoricarpos orbiculatus Moench; buckbrush; common in woodlands and unburned lowlands; Jul; shrub.

Triosteum perfoliatum L.; horse-gentian; infrequent at woodland edges; May–Jun; perennial.

CARYOPHYLLACEAE – Pink family

Arenaria serpyllifolia L.; thyme-leaf sandwort; infrequent in disturbed sites; May–Jun; introduced annual.

Cerastium brachypodum (Engelm. ex A. Gray) Rob.; mouse ear chickweed; rare in disturbed sites and along roads; Apr; annual.

Dianthus armeria L.; deptford pink; rare in disturbed sites and along roads; Jun–Jul; introduced annual.

Holosteum umbellatum L.; jagged chickweed; occasional in disturbed sites; Apr–May; introduced annual.

Saponaria officinalis L.; soapwort; rare around headquarters; Jun–Aug; introduced perennial.

Silene antirrhina L.; sleepy catchfly; occasional on uplands; May–Jun; annual.

Silene stellata (L.) Aiton; starry silene; occasional in woodlands; Jun–Jul; perennial.

Stellaria pallida (Dumort.) Crep.; lesser chickweed; occasional around headquarters; Mar–Jun; introduced annual.

CELASTRACEAE – Staff-tree family

Celastrus scandens L.; American bittersweet; infrequent in woodlands and on creek banks; May; woody vine.

Euonymus atropurpurea Jacq.; eastern wahoo; rare in woodlands and on creek banks; May–Jun; shrub.

CHENOPODIACEAE – Goosefoot family

Bassia scoparia (L.) Scott; [*Kochia scoparia*]; kochia, fireweed; infrequent in disturbed sites; Jul–Sep; introduced annual.

Chenopodium album L.; lamb's-quarters; rare in disturbed sites; Jun–Sep; introduced annual.

Chenopodium berlandieri Moq.; pit-seed goosefoot; occasional in disturbed sites; Jun–Oct; annual.

Chenopodium pallescens Standl.; pale goosefoot; rare on rocky prairie; Jul–Sep; annual.

Chenopodium simplex (Torr.) Raf.; [*Chenopodium gigantospermum*]; maple-leaf goosefoot; occasional at woodland edges and in disturbed lowlands; Jul–Sep; annual.

Chenopodium standleyanum Aellen; Standley's goosefoot; occasional in woodlands; Jul–Oct; annual.

Monolepis nuttalliana (Schult.) Greene; povertyweed; infrequent in ditches and disturbed sites; Apr–May; annual.

CLUSIACEAE – St. John's-wort family

Hypericum perforatum L.; common St. John's-wort; infrequent on uplands and lowlands; Jun–Jul; introduced perennial.

CONVOLVULACEAE – Morning-glory family

Calystegia macounii (Greene) Brummitt; hedge bindweed; infrequent in disturbed lowlands; May–Sep; perennial.

Convolvulus arvensis L.; field bindweed; infrequent in disturbed sites; May–Sep; introduced perennial.

Evolvulus nuttallianus Schult.; Nuttall's evolvulus; infrequent on shallow and rocky uplands; May–Jun; perennial.

Ipomoea hederacea Jacq.; ivy-leaf morning-glory; infrequent in ditches and disturbed lowlands; Jun–Sep; introduced annual.

Ipomoea lacunosa L.; white morning-glory; infrequent in disturbed lowlands; Aug–Sep; annual.

Ipomoea pandurata (L.) Mey.; big-root morning glory; infrequent in disturbed lowlands; Jun–Sep; perennial.

CORNACEAE – Dogwood family

Cornus amomum Mill.; pale dogwood; rare in ravines and on wooded slopes; May–Jun; shrub.

Cornus drummondii Mey.; rough-leaf dogwood; common in unburned prairie and woodlands; May–Jun; shrub.

CRASSULACEAE – Stonecrop family

Penthorum sedoides L.; ditch stonecrop; infrequent along creeks; Jul–Sep; perennial.

CUCURBITACEAE – Cucumber family

Cucurbita foetidissima Kunth; buffalo gourd; infrequent in ditches and along fence lines; Jun–Aug; perennial.

Sicyos angulatus L.; bur-cucumber; infrequent in woodlands; Aug -Sep; annual.

CUSCUTACEAE – Dodder family

Cuscuta glomerata Choisy; cluster dodder; infrequent on lowlands; Jul–Sep; annual forb parasitic on various Asteraceae species.

Cuscuta indecora Choisy; showy dodder; infrequent on lowlands; Aug–Sep; annual forb parasitic on numerous dicot species.

ELAEAGNACEAE – Oleaster family

Elaeagnus angustifolia L. Russian-olive; rare along creeks; May–Jun; introduced tree.

EUPHORBIACEAE – Spurge family

Acalypha ostryifolia Riddell; hop-hornbeam copperleaf; occasional in shaded lowlands and disturbed sites; Jul–Oct; annual.

Acalypha rhomboidea Raf.; rhombic copperleaf; infrequent in shaded lowlands and disturbed sites; Jul–Oct; annual.

Acalypha virginica L.; Virginia copperleaf; occasional in shaded lowlands and disturbed sites; Jul Oct; annual.

Chamaesyce glyptosperma (Engelm.) Small; [*Euphorbia glyptosperma*]; ridge-seed mat-spurge; infrequent on shallow uplands and in disturbed sites; Jul–Sep; annual.

Chamaesyce maculata (L.) Small; [*Euphorbia maculata*]; spotted mat spurge; occasional on grazed uplands and in disturbed sites; Jul–Oct; annual.

Chamaesyce missurica (Raf.) Shinners; [*Euphorbia missurica*]; Missouri mat-spurge; infrequent on rocky uplands; Jul Sep; annual.

Chamaesyce nutans (Lag.) Small; [*Euphorbia nutans*]; eyebane; occasional in unburned uplands and lowlands; Jul–Oct; annual.

Chamaesyce prostrata (Aiton) Small; [*Euphorbia prostrata*]; prostrate mat-spurge; occasional along roads and in disturbed sites; Jul–Sep; introduced annual.

Chamaesyce serpens (Kunth) Small; [*Euphorbia serpens*]; serpent mat-spurge; infrequent on grazed uplands and in disturbed sites; Jul–Oct; annual

Chamaesyce stictospora (Engelm.) Small; [*Euphorbia stictospora*]; slim-seed mat spurge; infrequent in disturbed sites; Jul–Oct; annual.

Croton capitatus Michx.; woolly croton; rare on rocky uplands; Jul–Sep; annual.

Croton monanthogynus Michx.; one-seed croton; occasional on shallow uplands and slopes; Jun–Sep; annual.

Euphorbia corollata L.; flowering spurge; infrequent on uplands and lowlands; Jul–Sep; perennial.

Euphorbia cyathophora Murray; painted spurge; infrequent in disturbed sites; Jul Sep; annual.

Euphorbia davidii Subils; western toothed spurge; infrequent in disturbed and unburned sites; Jul–Sep; annua..

Euphorbia dentata Michx.; eastern toothed spurge; infrequent in disturbed and unburned sites; Jul Sep; annual.

Euphorbia hexagona Nutt. ex Spreng.; six-angle spurge; rare in disturbed sites, Aug–Sep; annual.

Euphorbia marginata Pursh; snow on the mountain; occasional on uplands and in disturbed sites; Jul Sep; annual.

Euphorbia spathulata Lam.; warty spurge; occasional on uplands and rocky sites; May–Jun; annual.

Tragia betonicifolia Nutt.; nettle-leaf noseburn; occasional on shallow uplands and rocky sites; Jun–Aug; perennial.

Tragia ramosa Torr.; catnip noseburn; occasional on shallow uplands and rocky sites; Jun–Aug; perennial.

FABACEAE – Bean family

Amorpha canescens Pursh; leadplant; common on all prairie sites; Jun–Jul; shrub.

Amorpha fruticosa L.; indigobush amorpha; occasional in wet sites and along creeks; Jun–Jul; shrub.

Amphicarpaea bracteata (L.) Fernald; hog-peanut; occasional on shaded creek banks; Aug–Sep; perennial.

Astragalus canadensis L.; Canadian milk-vetch; rare on shaded slopes; Jul; perennial.

Astragalus crassicarpus Nutt.; ground plum milk-vetch; occasional on uplands; Apr–May; perennial.

Astragalus lotiflorus Hook.; lotus milk-vetch; infrequent on shallow uplands and slopes; Apr May; perennial.

Astragalus missouriensis Nutt.; Missouri milk vetch; infrequent on shallow uplands and slopes; May–Jun; perennial.

Astragalus plattensis Nutt.; Platte River milk-vetch; rare on rocky uplands; May–Jun; perennial.

Baptisia australis (L.) Br. ex Aiton; blue wild-indigo; common on uplands; May–Jun; perennial.

Baptisia × *bicolor* Greenm. & Larisey; [*B. australis* × *B. bracteata*]; bicolor wild-indigo; rare on uplands; May; perennial.

Baptisia bracteata Muhl. ex Elliott; plains wild-indigo; common on all prairie sites; Apr–May; perennial.

Cercis canadensis L.; eastern redbud; occasional in woodlands; Apr; tree.

Chamaecrista fasciculata (Michx.) Greene; [*Cassia chamaecrista*]; showy partridgepea; infrequent on lowlands and in ditches; Jul–Sep; annual.

Coronilla varia L.; crown-vetch; occasional on prairie adjacent to highway embankments; Jun–Sep; introduced perennial.

Crotalaria sagittalis L.; rattlebox; rare on shaded slopes; Jul–Sep; annual.

Dalea aurea Nutt. ex Pursh; silk top prairie clover; rare on shallow uplands; Jul–Aug; perennial.
Dalea candida Michx. ex Willd.; white prairie-clover; common on all prairie sites; Jun Jul; perennial.
Dalea leporina (Aiton) Bullock; fox-tail prairie-clover; rare in mesic lowlands; Aug–Sep; annual.
Dalea multiflora (Nutt.) Shinners; round-head prairie-clover; occasional on uplands and slopes; Jul; perennial.
Dalea purpurea Vent.; purple prairie-clover; common on uplands and slopes; Jun–Jul; perennial.
Desmanthus illinoensis (Michx.) MacMill. ex Rob. & Fernald; Illinois bundle-flower; infrequent on uplands and lowlands; Jul; perennial.
Desmodium canescens (L.) DC.; hoary tick-clover; infrequent on lowlands; Aug–Sep; perennial.
Desmodium glutinosum (Muhl. ex Willd.) Wood; large-flower tick-clover; occasional in wood lands; Jul–Aug; perennial.
Desmodium illinoense A. Gray; Illinois tick clover; occasional on uplands and lowlands; Jul; perennial.
Desmodium paniculatum (L.) DC.; panicled tick-clover; occasional at woodland edges; Aug–Sep; perennial.
Desmodium sessilifolium (Torr.) Torr. & A. Gray; sessile tick-clover; infrequent on lowlands and slopes; Aug–Sep; perennial.
Gleditsia triacanthos L.; honey-locust; occasional in woodlands and unburned lowlands; May; tree.
Glycyrrhiza lepidota Pursh; American licorice; in frequent on uplands and lowlands; Jun Jul; perennial.
Gymnocladus dioicus (L.) Koch; Kentucky coffee tree; infrequent in woodlands; May; tree.
Kummerowia stipulacea (Maxim.) Makino; [*Lespedeza stipulacea*]; Korean lespedeza; occasional in disturbed sites and along roads; Aug–Oct; introduced annual.
Lespedeza capitata Michx.; round-head lespedeza; common on lowlands; Aug–Sep; perennial.
Lespedeza cuneata (Dum. Cours.) Don; sericea lespedeza; rare on uplands and lowlands; Aug–Oct; introduced perennial.
Lespedeza stuevei Nutt. tall bush-clover; rare on lowlands; Aug–Sep; perennial.
Lespedeza violacea (L.) Pers.; prairie lespedeza; occasional on lowlands and slopes; Aug–Sep; perennial.
Medicago lupulina L.; black medic; occasional in disturbed sites; May–Sep; introduced annual.
Medicago sativa L.; alfalfa; rare in abandoned brome fields and ditches; Jun–Sep; introduced perennial.
Melilotus officinalis (L.) Lam.; yellow sweet-clover, white sweet-clover; occasional in ditches and disturbed sites; May–Jul; introduced biennial.
Mimosa nuttallii (DC.) Turner; [*Schrankia nuttallii*]; cat-claw sensitive-brier; occasional on uplands and slopes; Jun–Jul; perennial.
Pediomelum argophyllum (Pursh) Grimes; [*Psoralea argophylla*]; silver-leaf scurfpea; occasional on lowlands; Jun–Jul; perennial.
Pediomelum esculentum (Pursh) Rydb.; [*Psoralea esculenta*]; breadroot scurfpea; occasional on uplands and slopes; May; perennial.
Psoralidium tenuiflorum (Pursh) Rydb.; [*Psoralea tenuiflora*]; many-flower scurfpea; common on all prairie sites; Jun; perennial.
Robinia pseudoacacia L.; black locust; rare in woodlands; May; tree.
Senna marilandica (L.) Link; [*Cassia marilandica*]; wild senna; infrequent at woodland edges and on lowlands; Jul–Aug; perennial.
Strophostyles helvula (L.) Elliott; trailing wildbean; rare on shaded creek banks; Aug–Oct; annual.
Strophostyles leiosperma (Torr. & A. Gray) Piper; smooth-seed wildbean; infrequent on lowlands; Aug–Sep; annual.
Trifolium pratense L.; red clover; infrequent around headquarters; May–Sep; introduced perennial.
Trifolium repens L.; white clover; infrequent around headquarters; May Sep; introduced perennial.
Vicia americana Muhl. ex Willd.; American vetch; infrequent on lowlands and slopes; May–Jun; perennial.
Vicia villosa Roth; hairy vetch; infrequent in ditches and disturbed sites; May–Jun; introduced annual.

FAGACEAE – Oak family

Quercus macrocarpa Michx.; bur oak; common in woodlands; Apr–May; tree.

Quercus muehlenbergii Engelm.; chinquapin oak; common in woodlands; May; tree.

FUMARIACEAE – Fumitory family

Corydalis micrantha (Engelm. ex A. Gray) A. Gray; slender fumewort; infrequent on disturbed sites; Apr–May; annual.

Dicentra cucullaria (L.) Bernh.; Dutchman's-breeches; rare in woodlands; Apr–May; perennial.

GENTIANACEAE – Gentian family

Gentiana puberulenta Pringle; downy gentian; rare on lowlands; Sep–Oct; perennial.

GERANIACEAE – Geranium family

Geranium carolinianum L.; Carolina crane's-bill; infrequent in disturbed sites and along roads; May–Jun; annual.

GROSSULARIACEAE – Currant family

Ribes missouriense Nutt.; Missouri gooseberry; occasional in woodlands; Apr–May; shrub.

HIPPOCASTANACEAE – Buckeye family

Aesculus glabra Willd.; Ohio buckeye; infrequent in woodlands and along creeks; Apr–May; shrub.

HYDROPHYLLACEAE – Waterleaf family

Ellisia nyctelea (L.) L.; waterpod; occasional in woodlands and along creeks; May–Jun; annual.

JUGLANDACEAE – Walnut family

Carya cordiformis (Wangenh.) Koch; bitter-nut hickory; infrequent in woodlands; May; tree.

Juglans nigra L.; black walnut; occasional in woodlands; May; tree.

LAMIACEAE – Mint family

Agastache nepetoides (L.) Kuntze; catnip giant-hyssop; infrequent in woodlands; Aug–Oct; perennial.

Hedeoma hispida Pursh; rough false-penny-royal; occasional on grazed uplands and shallow sites; May–Jun; annual.

Isanthus brachiatus (L.) Britton et al.; [*Trichostema brachiatum*]; fluxweed; rare on slopes and rocky uplands; Jul–Sep; annual.

Lamium amplexicaule L.; hen-bit; common around headquarters; Mar–May; introduced annual.

Lycopus americanus Muhl. ex Barton; American bugleweed; infrequent in wet sites; Jul–Sep; perennial.

Marrubium vulgare L.; common horehound; infrequent in shaded and disturbed sites; Jun–Oct; introduced perennial.

Mentha arvensis L.; field mint; infrequent along creeks; Jul–Sep; perennial.

Monarda fistulosa L.; mint-leaf bee-balm, wild bergamot; occasional on lowlands and slopes; Jun–Jul; perennial

Nepeta cataria L.; catnip; occasional in shaded disturbed sites; Jun–Sep; introduced perennial.

Prunella vulgaris L.; selfheal; infrequent in woodlands and along creeks; Jun–Sep; perennial.

Salvia azurea Michx. ex Lam.; [*Salvia pitcheri*]; Pitcher's sage, blue sage; common on uplands; Jul–Sep; perennial.

Salvia reflexa Hornem.; lance leaf sage; occasional in disturbed sites and along roads; Jun–Sep; annual.

Scutellaria parvula Michx.; small skullcap; infrequent on uplands and rocky sites; May–Jun; perennial.

Teucrium canadense L.; American germander; common on lowlands; Jun–Jul; perennial.

LINACEAE – Flax family

Linum sulcatum Riddell; grooved flax; common on uplands; Jun–Jul; annual.

LOASACEAE – Stick-leaf family

Mentzelia oligosperma Nutt. ex Sims; stick-leaf; infrequent on slopes and rocky uplands; Jun–Sep; perennial.

LYTHRACEAE – Loosestrife family

Ammannia coccinea Rottb.; purple toothcup; infrequent in wet sites; Jul–Sep; annual.

Lythrum alatum Pursh; winged loosestrife; occasional in wet sites; Jun–Aug; perennial.

MALVACEAE – Mallow family

Abutilon theophrasti Medik.; velvetleaf; occasional in disturbed lowlands and cultivated fields; Jun–Oct; introduced annual.

Callirhoe alcaeoides (Michx.) A. Gray; pale poppy mallow; occasional on uplands and lowlands; May–Jun; perennial.

Callirhoe involucrata (Torr. & A. Gray) A. Gray; purple poppy-mallow; occasional on uplands and lowlands; May–Jul; perennial.

Hibiscus trionum L.; flower-of-an-hour; infrequent in disturbed lowlands and cultivated fields; Jun–Sep; introduced annual.

Malva neglecta Wallr.; common mallow; infrequent in disturbed lowlands; Jun Oct; introduced annual.

Malvastrum hispidum (Pursh) Hocnr.; rough false-mallow; infrequent in disturbed and unburned sites; Jun -Oct; annual.

Sida spinosa L.; prickly sida; infrequent in disturbed lowlands and cultivated fields; Jul–Oct; introduced annual.

MENISPERMACEAE – Moonseed family

Menispermum canadense L.; moonseed; common in woodlands; May–Jun; woody vine.

MOLLUGINACEAE – Carpetweed family

Mollugo verticillata L.; carpetweed; infrequent in disturbed sites; Jul–Sep; introduced annual.

MORACEAE – Mulberry family

Maclura pomifera (Raf.) Schneid.; osage-orange, hedge-apple; infrequent in unburned sites and woodlands; May; introduced tree.

Morus alba L.; white mulberry; occasional in woodlands; May; introduced tree.

NYCTAGINACEAE – Four-o'clock family

Mirabilis albida (Walt.) Heimerl; white four o'clock; infrequent on uplands and lowlands; Jun - Sep; perennial.

Mirabilis linearis (Pursh) Heimerl; narrow-leaf four-o'clock; infrequent on uplands; Jun–Sep; perennial.

Mirabilis nyctaginea (Michx.) MacMill.; wild four-o'clock; occasional at woodland edges and in disturbed sites; May–Sep; perennial.

OLEACEAE – Olive family

Fraxinus pennsylvanica Marshall; green ash; common in woodlands; Apr; tree.

ONAGRACEAE – Evening-primrose family

Calylophus serrulatus (Nutt.) Raven; serrate-leaf evening-primrose; infrequent on uplands and slopes; May–Jul; perennial.

Gaura mollis James; [*Gaura parviflora*]; small flower gaura, velvet gaura; infrequent in ditches and disturbed sites; Jul–Sep; annual.

Oenothera biennis L.; common evening-primrose; infrequent in disturbed sites; Jul–Sep; biennial.

Oenothera laciniata Hill; cut-leaf evening-primrose; rare in disturbed sites; May–Jul; annual.

Oenothera macrocarpa Nutt.; Missouri evening-primrose; occasional on shallow uplands and slopes; May–Jun; perennial.

Oenothera speciosa Nutt.; showy evening-primrose; occasional in mesic lowlands and ditches; Jun–Jul; perennial.

Stenosiphon linifolius (Nutt. ex James) Heynh.; flax-leaf stenosiphon; occasional on uplands and slopes; Aug–Sep; biennial.

OROBANCHACEAE – Broomrape family

Orobanche uniflora L.; one-flower broomrape; rare on lowlands; May; annual forb parasitic on roots of various dicots.

OXALIDACEAE – Wood-sorrel family

Oxalis dillenii Jacq.; gray-green wood sorrel; infrequent on uplands and in woodlands; Apr–Jun; perennial.

Oxalis stricta L.; yellow wood-sorrel; occasional on uplands and in woodlands; Apr–Jun; perennial.

Oxalis violacea L.; violet wood sorrel; occasional on lowlands; Apr–May; perennial.

PAPAVERACEAE – Poppy family

Argemone polyanthemos (Fedde) Ownbey; white prickly-poppy; infrequent on slopes and shallow uplands; Jun–Sep; annual.

PHYTOLACCACEAE – Pokeweed family

Phytolacca americana L.; pokeweed; occasional in woodlands and disturbed lowlands; Jun–Sep; perennial.

PLANTAGINACEAE – Plantain family

Plantago aristata Michx.; bottle-brush plantain; occasional on uplands and in disturbed sites; Jun–Jul; annual.

Plantago lanceolata L.; buck-horn plantain; rare in disturbed sites; Jun–Aug; introduced perennial.

Plantago patagonica Jacq.; woolly plantain; occasional on uplands and slopes; Jun–Jul; annual.

Plantago rhodosperma Decne.; red-seed plantain; common on uplands and in disturbed sites; May–Jun; annual.

Plantago rugelii Decne.; black-seed plantain; common in woodlands and shaded disturbed sites; Jun–Sep; perennial.

Plantago virginica L.; pale-seed plantain; occasional on uplands and in disturbed sites; May–Jun; annual.

PLATANACEAE – Sycamore family

Platanus occidentalis L.; sycamore; infrequent in woodlands; Apr–May; tree.

POLEMONIACEAE – Polemonium family

Phlox divaricata L.; blue phlox; occasional in woodlands; Apr–May; perennial.

POLYGALACEAE – Milkwort family

Polygala verticillata L.; whorled milkwort; infrequent on uplands and rocky sites; Jun–Sep; annual.

POLYGONACEAE – Buckwheat family

Polygonum amphibium L.; water smartweed; rare in ditches and wet sites; Jul–Sep; perennial.

Polygonum aviculare L.; prostrate knotweed; common on trails and in heavily disturbed sites; May–Oct; introduced annual.

Polygonum hydropiper L.; swamp water-pepper; rare in wet sites; Jul–Oct; annual.

Polygonum hydropiperoides Michx.; mild water pepper; rare in wet sites; Jul–Oct; perennial.

Polygonum lapathifolium L.; pale smartweed; infrequent in wet sites; Jul–Oct; annual.

Polygonum pensylvanicum L.; Pennsylvania smartweed; infrequent in wet sites; Jul–Oct; annual

Polygonum persicaria L.; lady's-thumb smartweed; infrequent in wet sites; Jul–Sep; introduced annual.

Polygonum punctatum Elliott; dotted smartweed; infrequent in wet sites; Jun–Oct; perennial.

Polygonum ramosissimum Michx.; bushy knotweed; infrequent in disturbed sites and along roads; Aug–Oct; annual.

Polygonum scandens L.; false buckwheat; infrequent at woodland edges and in disturbed sites; Aug–Sep; perennial.

Polygonum tenue Michx.; slim knotweed; infrequent on uplands; Jul–Oct; annual.

Polygonum virginianum L.; Virginia smartweed; occasional in woodlands; Jul–Sep; perennial

Rumex altissimus Wood; pale dock; infrequent in ditches and disturbed lowlands; Apr–Jun; perennial.

Rumex crispus L.; curly dock; infrequent in ditches and disturbed sites; May–Sep; introduced perennial.

PORTULACACEAE – Purslane family

Portulaca oleracea L.; common purslane; rare in disturbed sites; Jul–Sep; introduced annual.

PRIMULACEAE – Primrose family

Androsace occidentalis Pursh; western rock-jasmine; infrequent on shallow uplands and rocky sites; Apr–May; annual.

Lysimachia ciliata L.; fringed loosestrife; rare in wet sites and along creeks; Jun–Jul; perennial.

RANUNCULACEAE – Buttercup family

Anemone caroliniana Walter; Carolina anemone; infrequent on uplands; Apr–May; perennial.

Anemone virginiana L.; tall anemone; rare in woodlands; Jun–Jul; perennial.

Clematis pitcheri Torr. & A. Gray; Pitcher's clematis; rare in woodlands; Jun–Jul; perennial.

Delphinium carolinianum Walter; [*Delphinium virescens*]; plains larkspur; infrequent on uplands; May–Jun; perennial.

Myosurus minimus L.; tiny mousetail; rare in wet sites; Apr–May; annual.

Ranunculus abortivus L.; little-leaf buttercup; rare in wet sites; Apr–May; biennial.

Thalictrum dasycarpum Fisch. & Ave-Lall.; purple meadow-rue; rare in woodlands; May–Jun; perennial.

RHAMNACEAE – Buckthorn family

Ceanothus herbaceus Raf.; New Jersey tea, inland ceanothus; common in unburned uplands and slopes; Apr–May; shrub.

ROSACEAE – Rose family

Agrimonia pubescens Wallr.; downy agrimony; rare at woodland edges; Jul–Aug; perennial.

Crategus mollis Scheele; downy hawthorn, summer haw; rare on wooded slopes and along creeks; Apr–May; shrub.

Geum canadense Jacq.; white avens; common in woodlands and unburned lowlands; Jun–Jul; perennial.

Potentilla arguta Pursh; tall cinquefoil; infrequent on lowlands; Jun–Jul; perennial.

Potentilla recta L.; sulphur cinquefoil; rare in disturbed sites; May–Jun; introduced perennial.

Prunus americana Marshall; wild plum; occasional along creeks and in unburned sites; Mar–Apr; shrub.

Prunus angustifolia Marshall; chickasaw plum; infrequent along creeks and in unburned sites; Apr; shrub.

Prunus virginiana L.; choke cherry; infrequent along creeks and in unburned sites; Apr–May; shrub.

Rosa arkansana Porter; Arkansas rose; common in unburned prairie; May–Jun; shrub.
Rosa multiflora Thunb.; multiflora rose; rare in woodlands and unburned lowlands; May–Jul; introduced shrub.
Rubus occidentalis L.; black raspberry; occasional in woodlands and unburned lowlands; May–Jun; shrub.
Rubus ostryifolius Rydb.; high-bush blackberry; common in woodlands and unburned lowlands; May–Jun; shrub.

RUBIACEAE – Madder family

Galium aparine L.; catch-weed bedstraw; occasional in woodlands and unburned lowlands; May–Jun; annual.
Galium circaezans Michx.; woods bedstraw; occasional in woodlands; May–Jun; perennial.
Galium triflorum Michx.; sweet-scented bedstraw; occasional in woodlands; May–Jun; perennial.
Hedyotis nigricans (Lam.) Fosberg; narrow-leaf bluets; occasional on uplands and slopes; Jun–Jul; perennial.
Houstonia pusilla Schoepf; [*Hedyotis crassifolia*]; small bluets; rare on shallow uplands; Apr May; annual.

RUTACEAE – Citrus family

Zanthoxylum americanum Mill.; prickly ash; infre quent in woodlands and unburned low lands; Apr; shrub.

SALICACEAE – Willow family

Populus deltoides Bartram ex Marshall; cotton wood; occasional in wet sites; Apr; tree.
Salix amygdaloides Andersson; peach leaf wil low; infrequent in wet sites; May; tree.
Salix caroliniana Michx.; Carolina willow; infre quent in wet sites; Apr; tree.
Salix exigua Nutt.; sandbar willow; occasional in wet sites; Apr; shrub.
Salix nigra Marshall; black willow; infrequent in wet sites; Apr; tree.

SANTALACEAE – Sandalwood family

Comandra umbellata (L.) Nutt.; bastard toad-flax; common on shallow uplands and slopes; Apr–Jun; perennial.

SCROPHULARIACEAE – Figwort family

Agalinis aspera (Dougl. ex Benth.) Britton; rough agalinis; infrequent on uplands and slopes; Aug–Sep; annual.
Agalinis densiflora (Benth.) Blake; [*Tomanthera densiflora*]; fine leaf hairy-foxglove; rare on rocky uplands and slopes; Aug–Sep; annual.
Bacopa rotundifolia (Michx.) Wettst.; water-hys sop; rare in shallow water and mud; Jul–Aug; perennial.
Leucospora multifida (Michx.) Nutt.; paleseed; infrequent in wet sites; Jul–Sep; annual.
Mimulus glabratus Kunth; yellow monkey-flower; infrequent in wet sites; May–Aug; perennial.
Penstemon cobaea Nutt.; cobaea beardtongue; occasional on uplands and slopes; May–Jun; perennial.
Penstemon grandiflorus Nutt.; shell-leaf beard tongue, large beardtongue; infrequent on uplands and slopes; May–Jun; perennial.
Penstemon tubiflorus Nutt.; tube beardtongue; rare on uplands and slopes; May–Jun; perennial.
Scrophularia marilandica L.; Maryland figwort; occasional in woodlands; Jul–Sep; perennial.
Verbascum blattaria L.; moth mullein; occasional in ditches and disturbed sites; May–Sep; in troduced biennial.
Verbascum thapsus L.; flannel mullein; infrequent in ditches and disturbed sites; Jun–Sep; in troduced biennial.
Veronica agrestis L.; field speedwell; occasional in disturbed sites and around headquarters; Apr–Jun; introduced annual.
Veronica anagallis-aquatica L.; water speedwell; occasional in wet sites; May–Sep; perennial.
Veronica arvensis L.; corn speedwell; infrequent in disturbed lowlands; Apr–May; introduced annual.
Veronica peregrina L.; purslane speedwell; occa sional in wet sites; Apr–May; annual.

SOLANACEAE – Nightshade family

Datura stramonium L.; jimsonweed; rare in dis turbed sites; Jul–Oct; introduced annual.
Physalis hederifolia A. Gray; heart-leaf ground cherry; rare in disturbed sites; Jul–Aug; perennial.
Physalis heterophylla Nees; clammy ground cherry; infrequent on lowlands; Jun–Aug; perennial.
Physalis pubescens L.; downy ground-cherry; rare in woodlands and along creeks; Jun–Jul; annual.
Physalis pumila Nutt.; prairie ground-cherry; com mon on all prairie sites; Jun–Sep; perennial.
Physalis virginiana Mill.; Virginia ground-cherry;

occasional on lowlands and in disturbed sites; Jun–Sep; perennial.

Solanum carolinense L.; Carolina horse-nettle; occasional on lowlands and in disturbed sites; Jun–Sep; perennial.

Solanum ptychanthum Dunal; black nightshade; rare in wet sites and ditches; Jun Oct; annual.

Solanum rostratum Dunal; buffalo-bur nightsnade; occasional in disturbed sites; Jun -Sep; annual.

TILIACEAE – Linden family

Tilia americana L.; basswood; rare in woodlands; Jun; tree.

ULMACEAE – Elm family

Celtis occidentalis L.; hackberry; common in woodlands; Apr May; tree.

Ulmus americana L.; American elm; common in woodlands; Mar; tree.

Ulmus pumila L.; Siberian elm; occasional in woodlands; Mar–Apr; introduced tree.

Ulmus rubra Muhl.; red elm, slippery elm; infrequent in woodlands and along creeks; Mar–Apr; tree.

URTICACEAE – Nettle family

Laportea canadensis (L.) Wedd.; Canadian wood nettle; infrequent in woodlands; Jul–Sep; perennial.

Parietaria pensylvanica Muhl. ex Willd.; Pennsylvania pellitory; infrequent in woodlands and unburned lowlands; Jun Sep; annual.

Pilea pumila (L.) A. Gray; clearweed; occasional in wet sites; Aug Oct; annual.

Urtica dioica L.; stinging nettle; common in woodlands; Jul -Sep; perennial.

VERBENACEAE – Verbena family

Glandularia bipinnatifida (Nutt.) Nutt.; [*Verbena bipinnatifida*]; Dakota verbena; occasional on slopes and rocky sites; May–Jul; perennial.

Glandularia canadensis (L.) Nutt.; [*Verbena canadensis*]; rose verbena; infrequent on slopes; Apr–Jun; perennial.

Phryma leptostachya L.; lopseed; occasional in woodlands; Jul–Aug; perennia .

Phyla lanceolata (Michx.) Greene; [*Lippia lanceolata*]; northern fogfruit; occasional in wet sites; Jul–Sep; perennial.

Verbena bracteata Lag.& Rodr.; prostrate verbena, bigbract verbena; occasional in disturbed sites and along roads; Jun–Aug; perennial.

Verbena hastata L.; blue verbena; infrequent in mesic lowlands and along creeks; Jul Sep; perennial.

Verbena simplex Lehm.; narrow-leaf verbena; rare on slopes and rocky sites; Jun Aug; perennial.

Verbena stricta Vent.; woolly verbena; occasional on uplands and along roads; Jun–Sep; perennial.

Verbena urticifolia L.; white verbena, nettle-leaf verbena; occasional in woodlands and along creeks; Jul–Aug; perennial.

VIOLACEAE – Violet family

Hybanthus verticillatus (Ortega) Baill.; nodding green-violet; infrequent on uplands and slopes; May; perennial.

Viola bicolor Pursh; [*Viola rafinesquii*]; johnny-jump-up, field pansy; occasional on uplands and in disturbed sites; Apr–May; annual.

Viola pedatifida Don; prairie violet; occasional on all prairie sites; Apr–May; perennial.

Viola nephrophylla Greene; [*Viola pratincola*]; common violet; common in woodlands; Apr–Jun; perennial.

Viola sororia Willd.; downy blue violet; infrequent in woodlands; Apr–Jun; perennial.

VITACEAE – Grape family

Parthenocissus quinquefolia (L.) Planch.; Virginia creeper; common in woodlands; Jun–Jul; woody vine.

Vitis riparia Michx.; riverbank grape; occasional in woodlands; May; woody vine.

ZYGOPHYLLACEAE – Caltrop family

Tribulus terrestris L.; puncturevine; infrequent in disturbed sites and along trails; Jul–Sep; introduced annual.

Class LILIOPSIDA – Monocots

AGAVACEAE – Agave family

Yucca glauca Nutt.; small soapweed, yucca; infrequent on uplands and slopes; May–Jun; perennial.

ALISMATACEAE – Water-plantain family

Alisma subcordatum Raf.; subcordate water-plantain; infrequent in wet sites; Jul–Sep; perennial.

Echinodorus berteroi (Spreng.) Fassett; [*Echinodorus rostratus*]; burhead; infrequent in wet sites; Jun–Aug; annual.

Sagittaria latifolia Willd.; common arrowhead; infrequent in wet sites; Jul–Aug; perennial.

ARACEAE – Arum family

Arisaema dracontium (L.) Schott; dragonroot; rare in woodlands; May; perennial.

COMMELINACEAE – Spiderwort family

Commelina erecta L.; erect dayflower; infrequent at woodland edges; Jun–Oct; perennial.

Tradescantia bracteata Small ex Britton; bracted spiderwort; occasional in mesic lowlands; Apr–Jun; perennial.

Tradescantia ohiensis Raf.; Ohio spiderwort; rare in mesic lowlands; May Jun; perennial.

CYPERACEAE – Sedge family

Bolboschoenus fluviatilis (Torr.) Soják; [*Scirpus fluviatilis*]; river bulrush; rare around ponds; Jun–Jul; perennial.

Carex albicans Willd. ex Spreng.; [*Carex artitecta*]; white-tinge sedge; infrequent in woodlands; May–Jun; perennial.

Carex austrina Mack.; southern sedge; infrequent on uplands and lowlands; Apr Jun; perennial.

Carex blanda Dewey; woodland sedge; occasional in woodlands and along creeks; Apr Jun; perennial.

Carex brachyglossa Mack.; [*Carex annectens*]; yellow-fruit sedge; occasional in wet sites; May–June; perennial.

Carex brevior (Dewey) Mack. ex Lunell; straw sedge; common on uplands and lowlands; May–Jun; perennial.

Carex davisii Schwein. & Torr.; Davis' sedge; rare in woodlands; May–Jun; perennial.

Carex emoryi Dewey; Emory's sedge; rare in wet sites; May–Jun; perennial.

Carex frankii Kunth; Frank's sedge; infrequent in wet sites; May–Jun; perennial.

Carex gravida Bailey; heavy sedge; common on lowlands and in woodlands; Apr–Jun; perennial.

Carex grisea Wahlenb.; [*Carex amphibola*]; narrow-leaf sedge; common in woodlands and wet sites; Apr Jun; perennial.

Carex hyalinolepis Steud.; shoreline sedge; rare in wet sites; May–Jun; perennial.

Carex hystericina Muhl. ex Willd.; bottle brush sedge; common in wet sites; May–Jun; perennial.

Carex inops Bailey; [*Carex heliophila*]; prairie sedge; abundant on uplands; Apr–May; perennial.

Carex meadii Dewey; Mead's sedge; abundant on all prairie sites; Apr–May; perennial.

Carex molesta Mack. ex Bright; pest sedge; occasional on lowlands and in wet sites; May–June; perennial.

Carex pellita Muhl. ex Willd.; [*Carex lanuginosa*]; woolly sedge; occasional in wet sites; May–Jun; perennial.

Carex vulpinoidea Michx.; fox sedge; occasional in wet sites; May–Jun; perennial.

Cyperus acuminatus Torr. & Hook. ex Torr.; tapeleaf flat-sedge; occasional in wet sites; Jul–Sep; annual.

Cyperus bipartitus Torr.; [*Cyperus rivularis*]; brook flat-sedge; infrequent in wet sites; Jul–Sep; annual.

Cyperus esculentus L.; yellow nut-sedge; rare in mesic lowlands and ditches; Aug–Oct; perennial.

Cyperus lupulinus (Spreng.) Marcks; plains flat sedge; common on uplands; Jun–Jul; perennial.

Cyperus × *mesochorus* Geise; [*C. lupulinus* × *C. schweinitzii*]; intermediate flat-sedge; infrequent on uplands; Jun–Jul; perennial.

Cyperus odoratus L.; rusty flat-sedge; occasional in wet sites; Jul Sep; annual.

Cyperus squarrosus L.; [*Cyperus aristatus*]; awned flat-sedge; rare in wet sites; Jul Aug; annual.

Cyperus strigosus L.; straw flat-sedge; infrequent in wet sites; Aug–Sep; perennial.

Eleocharis compressa Sull.; flat-stem spike-rush; common in wet sites; Apr–Jun; perennial.

Eleocharis erythropoda Steud.; red-foot spike rush; common in wet sites; May–Jun; perennial.

Eleocharis macrostachya Britton; long stem spike-rush; common in wet sites; Apr–Jun; perennial.

Fuirena simplex Vahl; umbrella-sedge; infrequent in wet sites; Jul–Sep; annual.

Schoenoplectus tabernaemontani (Gmel.) Palla; [*Scirpus validus*]; soft stem bulrush; occasional in wet sites; Jun–Aug; perennial.

Scirpus atrovirens Willd.; green bulrush; common in wet sites; Jun–Jul; perennial.

Scirpus pendulus Muhl.; drooping bulrush; common in wet sites; May–Jul; perennial.

IRIDACEAE – Iris family

Sisyrinchium campestre Bicknell; prairie blue-eyed-grass; common on uplands; Apr–May; perennial.

JUNCACEAE – Rush family

Juncus dudleyi Wiegard; Dudley's rush; occasional in wet sites; Jun–Aug; perennial.

Juncus interior Wiegard; inland rush; common in mesic uplands and lowlands; May–Aug; perennial.

Juncus torreyi Coville; Torrey's rush; common in wet sites; Jun Aug; perennial.

LEMNACEAE – Duckweed family

Lemna minor L.; lesser duckweed; rare in shallow water; Jul–Sep; perennial.

LILIACEAE – Lily family

Allium canadense L.; wild onion; occasional on uplands; Apr Jun; perennial.

Allium stellatum Nutt. ex Ker Gawl.; pink onion; infrequent on uplands; Aug -Sep; perennial.

Asparagus officinalis L.; asparagus; rare at woodland edges; May–Jun; introduced perennial.

Erythronium albidum Nutt.; white fawn-lily; infrequent in woodlands; Apr; perennial.

Ornithogalum umbellatum L.; star-of-Bethlehem; rare around headquarters; Apr–May; introduced perennial.

Polygonatum biflorum (Walter) E liott; Solomon's seal; rare in woodlands; Jun; perennial.

Zigadenus nuttallii (A. Gray) Watson; Nuttall's death camas; occasional on uplands and lowlands; May–Jun; perennial.

NAJADACEAE – Naiad family

Najas guadalupensis (Spreng.) Magnus; common naiad; occasional in ponds; Aug Sep; annual.

ORCHIDACEAE – Orchid family

Spiranthes cernua (L.) Rich.; nodding ladies' tresses; rare on lowlands; Sep Oct; perennial.

Spiranthes vernalis Engelm. & A. Gray; spring ladies'-tresses; rare on lowlands; Jul–Aug; perennial.

POACEAE – Grass family

Aegilops cylindrica Host; jointed goat grass; rare in disturbed sites; May–Jun; introduced annual C_3.

Agrostis hyemalis (Walter) Britton et al.; tickle grass, winter bent grass; occasional on uplands; May–Jun; perennial C_3.

Agrostis stolonifera L.; redtop; infrequent along creeks; Jun–Jul; introduced perennial C_3.

Alopecurus carolinianus Walter; Carolina foxtail; infrequent in wallows and mesic uplands; Apr -Jun; annual C_3.

Andropogon gerardii Vitman; big bluestem; abundant on all prairie sites; Jul–Oct; perennial C_4.

Aristida oligantha Michx.; prairie threeawn; infrequent on disturbed sites; Aug–Sep; annual C_4.

Aristida purpurea Nutt.; purple threeawn; infrequent on uplands and rocky sites; Jun–Aug; perennial C_4.

Bothriochloa bladhii (Retz.) Blake; [*Andropogon bladhii*]; Caucasian bluestem; common on uplands and lowlands around headquarters; Jul Oct; introduced perennial C_4.

Bothriochloa ischaemum (L.) Keng; [*Andropogon ischaemum*]; Turkestan bluestem; common on uplands and lowlands around headquarters; Jul–Oct; introduced perennial C_4.

Bothriochloa laguroides (DC.) Herter; [*Andropogon saccharoides*]; silver bluestem; rare in ditches and disturbed sites; Jul–Sep; perennial C_4.

Bouteloua curtipendula (Michx.) Torr.; side-oats grama; abundant on uplands and slopes; Jul–Sep; perennial C_4.

Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths; blue grama; occasional on uplands and slopes; Jul–Aug; perennial C_4.

Bouteloua hirsuta Lag.; hairy grama; infrequent on shallow uplands and slopes; Jul–Sep; perennial C_4.

Bromus inermis Leyss.; smooth brome; common in fields near headquarters, ditches, and at woodland edges; May–Jun; introduced perennial C_3.

Bromus japonicus Thunb.; Japanese brome; common in disturbed sites and unburned prairie; Apr -Jun; introduced annual C_3.

Bromus pubescens Muhl. ex Willd.; woodland brome; common in woodlands; May Jun; perennial C_3.

Bromus tectorum L.; downy brome; infrequent in disturbed sites and unburned prairie; May–Jun; introduced annual C_3.

Buchloe dactyloides (Nutt.) Engelm.; buffalo grass; common on clay uplands and shallow sites; May–Aug; perennial C_4.

Cenchrus longispinus (Hack.) Fernald; sandbur; infrequent in disturbed sites and along trails; Jul Sep; annual C_4.

Chloris verticillata Nutt.; windmill grass; infrequent on shallow uplands; Jun–Sep; perennial C_4.

Cynodon dactylon (L.) Pers.; Bermuda grass; occasional around headquarters; Jun–Sep; introduced perennial C_4.

Dactylis glomerata L.; orchard grass; infrequent around headquarters; May–Jun; introduced perennial C_3.

Diarrhena obovata (Gleason) Brandenburg; [*Diarrhena americana* var. *obovata*]; American beakgrain; occasional in woodlands; Jul–Aug; perennial C_3.

Dichanthelium acuminatum (Sw.) Gould & Clark; woolly dichanthelium; occasional on all prairie sites; May–Jun; perennial C_3.

Dichanthelium oligosanthes (Nash) Gould; Scribner's dichanthelium; abundant on all prairie sites; May–Jun; perennial C_3.

Digitaria cognata (Schult.) Pilg.; [*Leptoloma cognatum*]; fall witch grass; infrequent on uplands and slopes; Jul–Sep; perennial C_4.

Digitaria sanguinalis (L.) Scop.; hairy crab grass; common around headquarters; Jul–Oct; introduced annual C_4.

Echinochloa muricata (Beauv.) Fernald; barnyard grass; occasional in ditches and disturbed sites; Jun–Sep; annual C_4.

Eleusine indica (L.) Gaertn.; goose grass; occasional in disturbed sites and along roads; Jul–Oct; introduced annual C_4.

Elymus canadensis L.; Canadian wild-rye; occasional on all prairie sites; Jun–Jul; perennial C_3.

Elymus villosus Muhl. ex Willd.; hairy wild-rye; occasional in woodlands; Jun–Jul; perennial C_3.

Elymus virginicus L.; Virginia wild-rye; occasional in woodlands; Jun–Jul; perennial C_3.

Eragrostis capillaris (L.) Nees; lace grass; rare on slopes; Jul–Sep; annual C_4.

Eragrostis cilianensis (All.) Vignolo ex Janch.; stink grass; occasional in disturbed sites and along roads; Jun–Oct; introduced annual C_4.

Eragrostis pectinacea (Michx.) Nees ex Steud.; Carolina love grass; occasional in disturbed sites and along roads; Jul–Oct; annual C_4.

Eragrostis spectabilis (Pursh) Steud.; purple love grass; occasional on all prairie sites; Aug–Sep; perennial C_4.

Eriochloa contracta Hitchc.; prairie cup grass; occasional in disturbed sites and along roads; Jul–Sep; annual C_4.

Festuca subverticillata (Pers.) Alexeev; [*Festuca obtusa*]; nodding fescue; infrequent in woodlands; May–Jun; perennial C_3.

Glyceria striata (Lam.) Hitchc.; fowl manna grass; occasional in wet sites and along creeks; May–Jun; perennial C_3.

Hesperostipa spartea (Trin.) Barkworth; [*Stipa spartea*]; porcupine grass; infrequent on uplands; May–Jun; perennial C_3.

Hordeum jubatum L.; fox-tail barley; infrequent in ditches and mesic lowlands; Jun; perennial C_3.

Hordeum pusillum Nutt.; little barley; occasional in disturbed sites and along roads; May; annual C_3.

Koeleria macrantha (Ledeb.) Schult.; [*Koeleria pyramidata*]; prairie June grass; common on uplands; May–Jun; perennial C_3.

Leersia oryzoides (L.) Sw.; rice cut grass; infrequent in wet sites and along creeks; Aug–Sep; perennial C_3.

Leersia virginica Willd.; white grass; occasional in wet sites and along creeks; Jul–Sep; perennial C_3.

Leptochloa fusca (L.) Kunth; [*Leptochloa fascicularis*]; bearded sprangletop; infrequent in disturbed sites; Jul–Sep; annual C_4.

Leptochloa panicea (Retz.) Ohwi; [*Leptochloa filiformis*]; red sprangletop; rare in disturbed sites; Jul–Sep; annual C_4.

Lolium arundinaceum (Schreb.) Darbyshire; [*Festuca arundinacea*]; tall fescue; occasional around headquarters; May–Jun; introduced perennial C_3.

Lolium perenne L.; rye grass; infrequent in disturbed sites and ditches; May–Jun; introduced perennial C_3.

Lolium pratense (Huds.) Darbyshire; [*Festuca pratensis*]; meadow fescue; infrequent around headquarters; May–Jun; introduced perennia C_3.

Muhlenbergia bushii Pohl; nodding muhly; occasional in woodlands; Aug–Sep; perennial C_4.

Muhlenbergia cuspidata (Torr. ex Hook.) Rydb.; plains muhly; occasional on uplands and slopes; Aug–Sep; perennial C_4.

Muhlenbergia frondosa (Poir.) Fernald; wire-stem muhly; occasional in woodlands and along creeks; Aug–Oct; perennial C_4.

Muhlenbergia mexicana (L.) Trin.; leafy muhly; infrequent in woodlands and along creeks; Sep–Oct; perennial C_4.

Muhlenbergia racemosa (Michx.) Britton et al.; marsh muhly, green muhly; occasional at

woodland edges and in mesic lowlands; Aug–Oct; perennial C_4.

Muhlenbergia schreberi Gmel.; nimblewill; occasional in woodlands; Aug–Oct; perennial C_4.

Panicum capillare L.; common witch grass; occasional in disturbed sites and along roads; Jul Oct; annual C_4.

Panicum dichotomiflorum Michx.; fall panicum; occasional in disturbed sites and along roads; Aug–Oct; annual C_4.

Panicum obtusum Kunth; vine mesquite; rare on lowlands and in mesic uplands; Jul Sep; perennial C_4.

Panicum virgatum L.; switch grass; common on all prairie sites; Jul–Oct; perennial C_4.

Pascopyrum smithii (Rydb.) Löve; [*Agropyron smithii*]; western wheat grass; occasional on clay uplands and in ditches; Jun; perennial C_3.

Paspalum pubiflorum Rupr. ex Fourn.; hairy-seed paspalum; rare along roads; Jul–Oct; perennial C_4.

Paspalum setaceum Michx.; sand paspalum; rare on clay uplands and shallow sites; Jul–Aug; perennial C_4.

Phleum pratense L.; timothy; rare in mesic lowlands and ditches; Jun; introduced perennial C_3.

Poa arida Vasey; plains blue grass; infrequent on mesic lowlands; May Jun; perennial C_3.

Poa chapmaniana Scribn.; Chapman's blue grass; rare in disturbed sites; May–Jun; annual C_3.

Poa compressa L.; Canadian blue grass; infrequent in unburned uplands and disturbed sites; May–Jun; introduced perennial C_3.

Poa pratensis L.; Kentucky blue grass; abundant in unburned prairie and woodlands; Apr Jun; introduced perennial C_3.

Schedonnardus paniculatus (Nutt.) Trel.; tumble grass; occasional on uplands and shallow soils; Jun–Aug; perennial C_4.

Schizachyrium scoparium (Michx.) Nasn; [*Andropogon scoparius*]; little bluestem; abundant on all prairie sites; Aug Sep; perennial C_4.

Setaria pumila (Poir.) Roem. & Schult.; [*Setaria glauca*]; yellow bristle grass; occasional in disturbed sites and along roads; Jul -Sep; introduced annual C_4.

Setaria viridis (L.) Beauv.; green bristle grass; infrequent in disturbed sites and along roads; Jun–Sep; introduced annual C_4.

Sorghastrum nutans (L.) Nash; Indian grass; abundant on all prairie sites; Aug–Oct; perennial C_4.

Sorghum halepense (L.) Pers.; Johnson grass; rare near cultivated fields; Jul–Oct; introduced perennial C_4.

Spartina pectinata Bosc ex Link; prairie cord grass; common in mesic lowlands and ditches; Jul–Sep; perennial C_4.

Sphenopholis obtusata (Michx.) Scribn.; prairie wedgescale; occasional on uplands and lowlands; May–Jun; perennial C_3.

Sporobolus compositus (Poir.) Merr.; [*Sporobolus asper*]; tall dropseed; abundant on all prairie sites and in abandoned brome fields; Aug–Oct; perennial C_4.

Sporobolus cryptandrus (Torr.) A. Gray; sand dropseed; infrequent on clay uplands and shallow soils; Jul -Aug; perennial C_4.

Sporobolus heterolepis (A. Gray) A. Gray; prairie dropseed; occasional on all prairie sites; Aug–Sep; perennial C_4.

Sporobolus neglectus Nash; puff-sheath dropseed; occasional along roads; Aug–Sep; annual C_4.

Sporobolus vaginiflorus (Torr. ex A. Gray) Wood; poverty dropseed; infrequent along roads; Aug–Sep; annual C_4.

Tridens flavus (L.) Hitchc.; purpletop; occasional on lowlands and in ditches; Jul–Sep; perennial C_4.

Tripsacum dactyloides (L.) L.; eastern gamma grass; occasional on lowlands around headquarters; Jun–Jul; perennial C_4.

Vulpia octoflora (Walter) Rydb.; [*Festuca octoflora*]; six-weeks fescue; occasional on grazed uplands and disturbed sites; Apr–May; annual C_3.

POTAMOGETONACEAE – Pondweed family

Potamogeton foliosus Raf.; leafy pondweed; rare in ponds; Jun–Aug; perennial.

Potamogeton nodosus Poir.; long-leaf pondweed; occasional in ponds; Jun Aug; perennial.

Potamogeton pusillus L.; baby pondweed; rare in ponds; Jun -Aug; perennial.

SMILACACEAE – Catbrier family

Smilax herbacea L.; carrion flower greenbrier; rare in woodlands; May Jun; perennial.

Smilax tamnoides L.; [*Smilax hispida*]; bristly greenbrier; common in woodlands; May Jun; woody vine

TYPHACEAE – Cat-tail family

Typha angustifolia L.; narrow-leaf cat-tail; rare in wet sites; Jun–Jul; perennial.

Typha latifolia L.; broad-leaf cat-tail; occasional in wet sites; Jun–Jul; perennial.

APPENDIX II

Non-naturalized ornamental and horticultural species growing around the headquarters area on Konza Prairie.

Family	Species	Common name
Araliaceae	*Hedra helix*	English ivy
Bignoniaceae	*Catalpa speciosa*	Northern catalpa
Caprifoliaceae	*Lonicera tatarica*	Tatarian honeysuckle
Cupressaceae	*Juniperus horizontalis*	Creeping juniper
Iridaceae	*Iris germanica*	Iris
Liliaceae	*Amaryllis bella-donna*	Naked ladies
Liliaceae	*Narcissus poeticus*	Poet's narcissus
Liliaceae	*Narcissus pseudonarcissus*	Daffodil
Oleaceae	*Syringa vulgaris*	Lilac
Paeoniaceae	*Paeonia lactiflora*	Peony
Pinaceae	*Pinus nigra*	Austrian pine
Rosaceae	*Malus sylvestris*	Apple
Rosaceae	*Pyrus communis*	Pear
Sapindaceae	*Koelreuteria paniculata*	Golden rain-tree

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THE VASCULAR FLORA OF THE CERRADO IN EMAS NATIONAL PARK (GOIÁS, CENTRAL BRAZIL)

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ABSTRACT

The cerrado, a savanna-like ecosystem, is the second largest vegetation type in Brazil, originally covering about two million km^2 (or 23%) of the Brazilian territory. The Emas National Park (ENP), comprising about 133,000 ha, is one of the most important reserves within the cerrado. From November 1998 to October 1999, we carried out a floristic survey of all the cerrado physiognomies of the ENP and found 601 species, belonging to 303 genera and 80 families. Among the collected species, 12 were weeds and seven were new to science. The herbaceous to woody species ratio was 3.03:1. The richest families were Asteraceae (88 species), Fabaceae (87), Poaceae (51), Myrtaceae (39), and Lamiaceae (24); these five families comprised 48% of the total number of species. The results obtained show the importance of the ENP to cerrado conservation, since from 8 to 20% of the species recorded for this vegetation type occur within the reserve. We emphasize the need for more floristic surveys in which the frequently overlooked herbaceous component should also be sampled.

Key words: cerrado, savanna, floristics, Emas National Park, central Brazil

RESUMEN

El cerrado, un tipo de sabana, es el segundo mayor tipo de vegetación de Brasil. Una de las reservas más importantes destinada a proteger el cerrado es el "Parque Nacional das Emas" (PNE), con un área aproximada de 133.000 ha. En el periodo de noviembre de 1998 a octubre de 1999, fue realizado un levantamiento florístico en las fisionomías de cerrado del PNE, encontrándose 601 especies pertenecientes a 303 géneros y 80 familias. De entre las especies colectadas, fueron encontradas 12 invasoras y siete nuevas para la ciencia. La proporción entre especies herbáceo-subarbustivas y arbustivo-arbóreas fue de 3,03:1. Las familias más ricas en especies fueron: Asteraceae (88 especies), Fabaceae (87), Poaceae (51), Myrtaceae (39) e Lamiaceae (24), compreendiendo 48% del total de especies. Los resultados mostraron la importancia del PNE para la conservación del cerrado, ya que en esta reserva aparecen de 8 a 20 % de las especies listadas para dicha formación vegetal. Resaltamos aquí la necesidad de realizar levantamientos florísticos contemplando también el componente herbáceo-subarbustivo, frecuentemente olvidado.

INTRODUCTION

The Cerrado Domain, the second largest Brazilian phytogeographic province, once covered about 2 million km^2, or 23% of the Brazilian territory, with its core area in central Brazil (Ratter et al. 1997). As its name implies, cerrado vegetation prevails in the Cerrado Domain. The cerrado vegetation is not uniform in physiognomy (Coutinho 1990), ranging from grassland to tall woodland, but most of its physiognomies within the range defined as tropical savanna

(Sarmiento 1983). In the Cerrado Domain, interspersed with the prevailing cerrado vegetation, there are other vegetation types, such as seasonal forest, riparian forest, rocky *campo*, and wet *campo*.

Although frequently neglected in the past, the cerrado vegetation stands out in its high floristic richness (Ratter et al. 1997). After comparing a large number of floristic and phytosociological surveys carried out in cerrado sites from all over Brazil, Castro et al. (1999) estimated that 3,000 to 7,000 vascular plant species occur in this vegetation type. In addition to its high floristic richness, the cerrado presents a high degree of endemism. Lenthall et al. (1999), for instance, listed 234 woody species occurring in 10 cerrado sites and verified that 80% of them were restricted to this vegetation type. Owing to its high richness, high degree of endemism, and present conservation status, Fonseca et al. (2000) included the cerrado among the biodiversity hotspots for highest priority conservation in the world.

According to Rizzini (1963), the cerrado flora consists of an herbaceous and a woody component, which compete because both are heliophilous, i.e., there is no shade-adapted ground layer. Following Coutinho's (1990) concept of cerrado, the importance of the herbaceous component decreases from open to closed physiognomies, whereas the importance of the woody component increases. In most forms of cerrado, the herbaceous component is much richer in species, as demonstrated by Mantovani and Martins (1993), who found a ratio between herbaceous and woody species ranging from 2:1 to 3:1 in the comparison of some southern cerrado sites. However, despite its richness, Castro et al. (1999) pointed out the almost complete absence of existing surveys on the herbaceous component of the cerrado. These authors also highlighted the uneven distribution of surveys, which tend to be concentrated on few well studied areas (Castro et al. 1999).

The Emas National Park (ENP) is the largest and one of the most important reserves among those in the Cerrado Domain (Conservation International 1999). Although some papers about its fauna and wildfires exist (e.g., Ramos-Neto & Pivello 2000; Rodrigues & Monteiro 2000), the ENP's vegetation remains poorly studied. The present work was designed as an intense and systematic floristic survey to provide a better knowledge of the ENP's flora in particular and of the cerrado flora in general, especially concentrating on the still poorly known herbaceous component. Furthermore, this survey is intended to provide a basis for other studies to be carried out in the ENP and for phytogeographical studies on the cerrado flora.

To achieve these aims, we have tried to answer the following questions: What is the floristic composition of the cerrado physiognomies in ENP? Which families are the richest ones in its flora? Does the herbaceous to woody species ratio lie within the range described by Mantovani and Martins (1993), that is, be-

tween 2:1 and 3:1? Are there woody species that should be included in the checklist elaborated by Castro et al. (1999)?

SITE SUMMARY

Created in 1961, the ENP is located in the Brazilian Central Plateau, southwestern Goiás State (17°49'-18°28'S, 52°39'-53°10'W), in the cerrado core region, and comprises 132,941 ha. Regional climate is humid tropical with wet summer and dry winter, classified as Aw following Köppen's (1948) system. Annual rainfall varies from 1,200 to 2,000 mm, concentrated from October to March, and mean annual temperature lies around 24,6°C (Ramos-Neto & Pivello 2000). Three quarters of the ENP consist of flat tableland, 820–888 m high, and the remaining area consists of hilly terrain, 720–820 m high (Ramos-Neto & Pivello 2000). Recently, ENP was included by UNESCO (2001) in the World Natural Heritage List as one of the sites containing flora, fauna, and key habitats that characterize the cerrado.

The cerrado in ENP exhibits almost all physiognomies found in this vegetation type. Following Coutinho's (1990) classification and Sarmiento's (1984) translation, the cerrado in ENP ranges from *campo limpo* (a grassland) to *cerrado sensu stricto* (a woodland). In the reserve, open cerrado physiognomies—*campo limpo, campo sujo* (a shrub savanna), and *campo cerrado* (a savanna woodland)—prevail, covering 68.1% of the total area, especially on the flat tableland (Ramos-Neto & Pivello 2000). The more closed *cerrado sensu stricto* covers 25.1% of the reserve, mainly on the hilly terrain. Other vegetation types, such as wet campo (4.9% of the total area) and riparian and seasonal semideciduous forests (1.2%), also exist within the park.

METHODS

We surveyed all cerrado physiognomies occurring within the reserve from November 1998 to October 1999, in monthly field trips, each one with a 50–60 hr. sampling effort in the field. We established routes through the firebreaks that cross the reserve (Fig. 1) and covered one of them each day by driving a vehicle and stopping whenever vegetation of interest was seen. The routes comprised the following reference points (with approximate distances): i) U2, U1, Q, R, S, T, U2 (51.5 km); ii) U2, V, P1, O, U1 (52.5 km); iii) O, M, N, P1 (45 km); iv) V, P2, W, Y, V (47.5 km); v) X, Z1, Z2, Z3, Z2, Z1, Y, W, X (47.5 km); vi) A, B, J, G, D, C, K2, K1, A (48 km).

We collected fertile botanical material along the pre-established routes. During the last two field trips, we also collected sterile material from species previously not found in reproductive stages. The collected material was identified to species level by comparing it with lodged vouchers and consulting taxonomic references. The specimens were then sent to taxonomists for confirma-

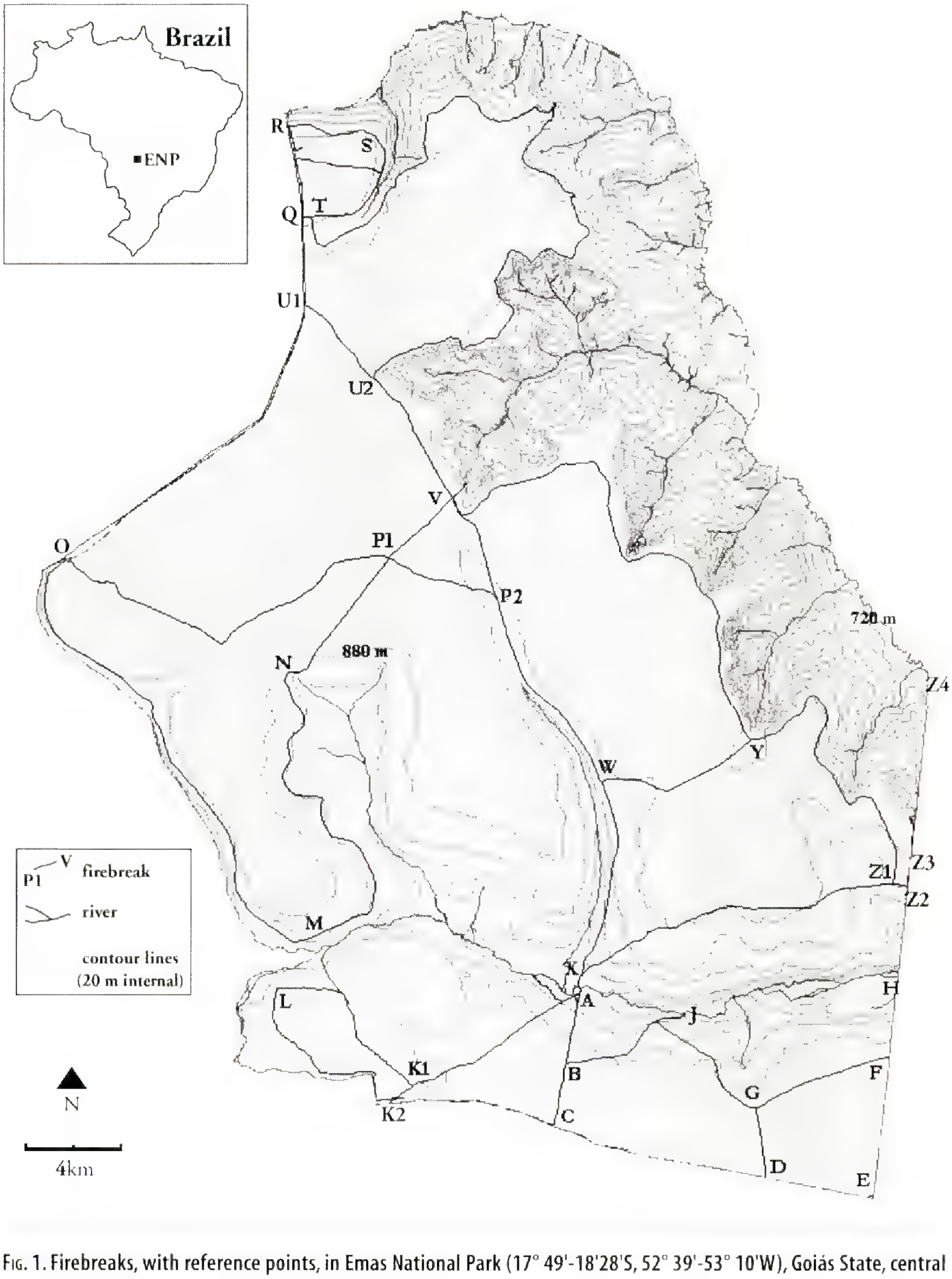


Fig. 1. Firebreaks, with reference points, in Emas National Park (17° 49'-18'28'S, 52° 39'-53° 10'W), Goiás State, central Brazil.

tion. The voucher material was stored in the herbaria of the São Paulo Botanical Institute (SP) and State University of Campinas (UEC).

We classified the species in families according to the system proposed by Judd et al. (1999) and in life forms following Raunkiaer's (1934) system adapted by Mueller-Dombois and Ellenberg (1974). We considered the chamaephytes,

epiphytes, hemicryptophytes, geophytes, lianas, vascular parasites, and therophytes as belonging to the herbaceous component and the phanerophytes as belonging to the woody component. We applied the chi-square test (Zar 1999) to verify whether the herbaceous to woody species ratio was significantly different from the expected by Mantovani and Martins (1993). The results found were also compared to the patterns obtained by Castro et al. (1999).

RESULTS

We collected 2,123 voucher specimens, representing 601 species, 303 genera, and 80 families (Appendix I). Out of these 601 species, 571 were identified to species level, including one new to science, *Piriqueta emasensis* Arbo (Turneraceae). Six out of the remaining 30 species were also new to science and are currently being described by taxonomists: *Annona* sp. nov. (Annonaceae), *Gyrostelma* sp. nov. (Apocynaceae), *Dimmerostema* sp. nov. (Asteraceae), *Ipomoea* sp. nov. (Convolvulaceae), *Hybanthus* sp. nov. (Violaceae), and another Convolvulaceae that belongs to a new genus. There were 22 species identified to genus level, one identified to family level (Fabaceae sp.), and one that we could not identify even to family level.

Twelve species (2.0% of the total number of species) were considered by Mendonça et al. (1998) as weeds that do not occur spontaneously in the cerrado. Of the 601 species, 149 were phanerophytes and thus included in the woody component, while 452 belonged to other life forms and were included in the herbaceous component. The herbaceous to woody species ratio was 3.03:1, a value not significantly different ($\chi^2 = 0.014$, $P = 0.906$) from the highest ratio (3:1) set by Mantovani and Martins (1993).

The richest families were Asteraceae (88 species), Fabaceae (87), Poaceae (51), Myrtaceae (39), Lamiaceae (24), Malpighiaceae (23), Euphorbiaceae (20), Apocynaceae (19), Malvaceae (16), Rubiaceae (16), and Convolvulaceae (15), which together summed up 66.2% of the total number of species. In the herbaceous component, the richest families were Asteraceae (85 species), Fabaceae (59), Poaceae (48), Lamiaceae (23), Euphorbiaceae (19), Malpighiaceae (16), Myrtaceae (16), Convolvulaceae (15), and Apocynaceae (14), which comprised 65.27% of the herbaceous species. In the woody component, the richest families were Fabaceae (28), Myrtaceae (23), Malpighiaceae (7), Melastomataceae (7), Annonaceae (6), Apocynaceae (5), Vochysiaceae (5), Bignoniaceae (4), Nyctaginaceae (4), and Rubiaceae (4), which together accounted for 62.42% of the woody species.

Seventeen out of the 149 woody species (11.4%) did not appear on the checklist of the cerrado woody flora established by Castro et al. (1999): *Annona* sp. nov., *Aiouea trinervis* Meisn., *Apoclada arenicola* McClure, *Banisteriopsis acerosa* (Nied.) B. Gates, *Calliandra macrocalyx* Harms, *Dalbergia cuiabensis* Benth., *Mimosa amnis-atri* Barneby, *M. gemmulata* Barneby, *M. hebecarpa* Benth.,

Myrcia bracteata O. Berg, *M. camapuanensis* N.F.E. Silveira, *M. crassifolia* (O. Berg) Kiaersk., *M. fallax* (Rich.) A. DC., *M. linguaeformis* Kiaersk., *M. rhodeosepala* Kiaersk., *Olyra taquara* Sw., and *Psidium laruotteanum* Cambess.

DISCUSSION

If we assume that the number of species in the cerrado ranges from 3,000 to 7,000 (Castro et al. 1999), then the ENP contains approximately 8.5 to 20.0% of the cerrado flora. These figures show the importance of this reserve for the conservation of the cerrado vegetation. The number of species in ENP might be increased by species not found in our survey. Floristic surveys certainly miss a number of species in a given area, especially those that are not at reproductive stage at the time of the visit, flower sporadicaly, are ephemeral, or are inconspicuous, problems that particularly affect the herbaceous component of the vegetation (Mantovani & Martins 1993; Castro et al. 1999).

Among the 601 species found in the ENP, seven are new to science. Although the cerrado is one of the most studied vegetation types in Brazil (Castro et al. 1999), the fact that undescribed species keep on appearing in floristic surveys—for example, also in Brasília, Federal District (Pereira et al. 1993)—shows that the cerrado has not yet been satisfactorily sampled. The affirmation that the tropical flora remains undercollected (Prance et al. 2000) seems to apply also to the cerrado vegetation. Some of the species not identified to species level in our inventory may be new to science as well.

Although the proportion of weedy species in the ENP's cerrado flora was lower than the ca. 5% found by Mendonça et al. (1998) for the whole Cerrado Domain, the invasion of ruderal plants in ENP is alarming, notably the African grasses *Brachiaria decumbens* Stapf and *Melinis minutiflora* P. Beauv. Plant invasion has become a great problem in virtually all cerrado fragments (Pivello et al. 1999) and will grow into a serious problem in the ENP if precautions are not taken.

The richest families in the ENP were also the richest ones in other cerrado sites (Mantovani & Martins 1993; Batalha et al. 1997; Batalha & Mantovani 2000). Exceptions were Convolvulaceae and Lamiaceae, well represented only in the ENP. The herbaceous to woody species ratio, although not significantly different from the maximum set by Mantovani and Martins (1993), was higher than the ratios found in other surveys (Mantovani & Martins 1993; Batalha et al. 1997; Batalha & Mantovani 2000). This probably was a consequence of the prevalence of open physiognomies (*campo limpo* and *campo sujo*) in ENP.

According to Castro et al. (1999), surveys in poorly sampled regions should augment the cerrado woody species checklist. Indeed, the 17 species found in our survey that should be included in their list represent a high percentage of the species collected in ENP and indicate that even the woody component of the cerrado vegetation remains undercollected. As for the herbaceous compo-

nent, this undercollection might be even greater. In the visits we paid to herbaria and in our search for references, the absence of surveys in this component became evident.

Species inventories, even at the most basic level, are available for only about 1% of the tropical regions (Hammond 1992). Our floristic survey of the dominant cerrado vegetation in the ENP represents a first step, and it will be necessary to survey the other vegetation types existing within the reserve, such as seasonal semideciduous forest, riparian forest, wet *campo*, and the aquatic vegetation of streams, rivers, and lakes.

APPENDIX I

Species collected in the floristic survey of the cerrado vegetation in Emas National Park (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil. Taxa were listed alphabetically by family, genus, and species. The format used was species name, authority, collection number, and life form. Authorities were abbreviated according to Brummit and Powell (1992). Species designated by an asterisk (*) were considered non-native weeds by Mendonça et al. (1998). All specimens were collected by M.A. Batalha (B). Life form was assigned according to Raunkiaer's (1934) system adapted by Muller-Dombois and Ellenberg (1974). Life form classes were abbreviated as: Ch = chamaephyte, Ep = epiphyte, Geo = geophyte, H = hemicryptophyte, Li = Liana, Ph = phanerophyte, Th = therophyte, and Vp = vascular parasite.

APPENDIX I

The vascular flora of the cerrado in Emas National Park (central Brazil).

ACANTHACEAE
Hygrophila brasiliensis (Spreng.) Lindau, B 2306, H
Ruellia geminiflora Kunth, B 2169, H
Ruellia incompta (Nees) Lindau, B 3592, Ch

ALSTROEMERIACEAE
Alstroemeria gardneri Baker, B 2715, H

AMARANTHACEAE
Froelichia procera (Seub.) Pedersen, B 2123, H
Gomphrena arborescens L. f., B 2395, H
Gomphrena macrocephala A. St-Hil., B 2214, H
Gomphrena pohlii Moq., B 2091, H
Pfaffia helichrysoides (Moq.) Kuntze, B 2152, H
Pfaffia jubata Mart., B 2283, H

ANACARDIACEAE
Anacardium humile A. St-Hil., B 2050, Ch
Tapirira guianensis Aubl., B 3804, Ph

ANNONACEAE
Annona coriacea Mart., B 695, Ph
Annona crassiflora Mart., B 2403, Ph
Annona monticola Mart., B 3620, H
Annona tomentosa R.E. Fries, B 2347, Ch
Annona warmingiana Mello-Silva & Pirani, B 3763, H
Annona sp. nov., B 2621, Pn
Bocageopsis mattogrossensis (R.E. Fries) R.E. Fries, B 3506, Ph
Duguetia furfuracea (A. St-Hil.) Benth. & Hook. f., B 2180, Ph
Duguetia glabriuscula (R.E. Fries) R.E. Fries, B 1955, Ch
Xylopia aromatica (Lam.) Mart., B 2515, Ph

APIACEAE
Didymopanax macrocarpum (Cham. & Schltdl.) Seem., B 2107, Ph
Didymopanax malmei Harms, B 2733, Ph
Eryngium ciliatum Cham. & Schltdl., B 3890, H
Eryngium junceum Cham. & Schltdl., B 2566, H

APOCYNACEAE
Asclepias mellodora A. St-Hil., B 2967, H

Aspidosperma macrocarpon Mart., B 2232, Ph
Aspidosperma nobile Müll. Arg., B 3661, Ph
Aspidosperma tomentosum Mart., B 4028, Ph
Barjonia cymosa Fourn., B 2897, H
Barjonia erecta (Vell.) K. Schum., B 2182, H
Blepharodon bicuspidatum Fourn., B 2451, Li
Gyrostelma sp. nov., B 2081, H
Hancornia speciosa Gomez, B 2106, Ph
Hemipogon acerosus Decne., B 2083, H
Himatanthus obovatus (Müll. Arg.) Woods., B 2380, Ph
Macrosiphonia longiflora Müll. Arg., B 2218, H
Macrosiphonia velame (A. St-Hil.) K. Schum., B 2610, H
Mandevilla coccinea (Hook. & Arn.) Woods., B 2577, H
Mandevilla pohliana (Standelm.) A. Gentry, B 2099, H
Odontadenia lutea (Vell.) Markgr., B 2645, Li
Oxypetalum aequaliflorum Fourn., B 2241, H
Rauvolfia weddelliana Müll. Arg., B 1962, H
Rhodocalyx rotundifolius Müll. Arg., B 2281, H

ARACEAE

Scaphispatha gracilis Brongn. ex Schott, B 2075, H

ARECACEAE

Acrocomia aculeata (Jacq.) Lodd. ex Mart., B 2498, Ph
Acrocomia hassleri (Barb. Rodr.) Hahn, B 3828, Geo
Allagoptera campestris (Mart.) Kuntze, B 2006, Geo
Allagoptera leucocalyx (Mart.) Kuntze, B 2215, Geo
Attalea geraensis Barb. Rodr., B 2509, Geo
Syagrus flexuosa (Mart.) Becc., B 2249, Geo

ARISTOLOCHIACEAE

Aristolochia gibertii Hook., B 2852, Li
Aristolochia gracilis Duch., B 4029, Li

ASTERACEAE

Acanthospermum australe (Loefl.) Kuntze, B 2527, Th
Achyrocline satureoides (Lam.) A. DC., B 3400, Th
Apopyros warmingii (Baker) Nesom, B 2176, H
Aspilia foliacea (Spreng.) Baker, B 3377, H
Aspilia laevissima Baker, B 2704, H
Aspilia leucoglossa Malme, B 2122, H
Aspilia platyphylla (Baker) Blake, B 2848, H
Ayapana amygdalina (Lam.) King & H. Rob., B 3458, H
Baccharis camporum A. DC., B 3313, Ch
Baccharis humilis Sch. Bip., B 2172, H
Bidens gardneri Baker, B 3031, Th
Calea clausseniana Baker, B 3771, H
Calea cuneifolia A. DC., B 4011, H
Calea hymenolepis Baker, B 2886, H
Calea platylepis Sch. Bip. ex Baker, B 3204, H
Campuloclinium chlorolepis Baker, B 3120, H
Campuloclinium megacephalum (Mart.) King & H. Rob., B 2605, H
Chaptalia integerrima (Vell.) Burkart, B 2089, Th
Chromolaena chaeseae H. Rob., B 3314, Ch
Chromolaena leucocephala Gardner, B 3409, Ch
Chromolaena squalida (A. DC.) King & H. Rob., B 2328, Ch
Chromolaena stachyophylla (Spr.) King & H. Rob., B 3416, H
Conyza bonariensis (L.) Cronq., B 2497, Th
Dasyphyllum sprengelianum (Gardner) Cabrera, B 3042, Ch
Dimmerostema asperatum Blake, B 2592, H
Dimmerostema brasilianum Cass., B 3161, H
Dimmerostema retifolium (Sch. Bip.) Blake, B 2246, H
Dimmerostema sp. nov., B 2010, H
Elephantopus biflorus Less., B 3159, H
Elephantopus mollis L., B 3128, H
Elephantopus racemosus Gardner, B 3412, H
Emilia coccinea (Sims.) Sweet *, B 2364, Th
Erechtites hieracifolia (L.) Raf. *, B 2368, Th
Eremanthus erythropappus Sch. Bip., B 2213, Ph
Eremanthus glomerulatus Less., B 3333, Ph
Eremanthus sphaerocephalus Baker, B 2273, H
Eupatorium betonicaeforme Baker, B 3402, H
Eupatorium campestre A. DC., B 1996, H
Eupatorium lanigerum Hook. & Arn., B 3946, H
Eupatorium myriocephalum Gardner, B 3406, Ch
Eupatorium purpurascens Sch. Bip., B 3093, H
Eupatorium urticifolium L. f., B 1973, H
Eupatorium sp., B 3309, H
Gochnatia barrosoae Cabrera, B 3484, Ch
Gochnatia pulchra Cabrera, B 3014, Ch
Hoehnephyton trixoides (Gardner) Cabrera, B 3596, H
Ichthyothere sp. 1, B 2121, H
Ichthyothere sp. 2, B 3792, H
Ichthyothere sp. 3, B 3563, H
Isostigma megapotamicum Scherff, B 2149, H
Isostigma sp., B 3819, H
Mikania cordifolia (L.) Willd., B 3156, Li

Orthopappus angustifolius (Sw.) Gleason *, B 2402, H
Piptocarpha rotundifolia (Less.) Baker, B 1957, Ph
Porophyllum angustissimum Gardner, B 2513, Th
Pseudobrickellia pinifolia (Spr.) King & H. Rob., B 3491, H
Pterocaulon virgatum (L.) A. DC., B 3155, H
Riencourtia oblongifolia Gardner, B 2331, H
Riencourtia tenuifolia Gardner, B 2256, H
Spilanthes nervosa Chod., B 1900, H
Stilpnopappus glomerulatus Gardner, B 2877, H
Stilpnopappus speciosus Baker, B 2504, H
Stomatanthes dictyophyllum (A. DC.) King & H. Rob., B 2555, H
Vernonia argentea Less., B 2388, H
Vernonia bardanoides Less., B 2514, H
Vernonia brevipetiolata Sch. Bip., B 3189, H
Vernonia buddleiifolia Sch. Bip. ex Baker, B 2338, H
Vernonia compactiflora Mart. ex Baker, B 2867, H
Vernonia desertorum Mart. ex A. DC., B 3567, H
Vernonia erythrophylla Mart., B 2094, H
Vernonia ferruginea Less., B 3510, H
Vernonia grandiflora Less., B 2487, H
Vernonia herbacea (Vell.) Rusby, B 1992, H
Vernonia ignobilis Less., B 2168, H
Vernonia polyanthes (Spreng.) Less., B 2336, Ch
Vernonia psilophylla A. DC., B 2832, H
Vernonia rubricaulis Humb. & Bonpl., B 2375, H
Vernonia rubriramea Mart., B 3191, Ch
Vernonia simplex Less., B 4014, H
Vernonia tomentella Mart. ex A. DC., B 2063, H
Vernonia tragiaefolia A. DC., B 2172, H
Vernonia varroniifolia A. DC., B 3304, H
Vernonia venosissima Sch. Bip. ex Baker, B 2001, H
Vernonia virgulata Mart., B 2033, H
Viguiera bakeriana Blake, B 2414, H
Viguiera sp. 1, B 2084, H
Viguiera sp. 2, B 1960, H
Wedelia macedoi H. Rob., B 3920, H

BALANOPHORACEAE

Langsdorffia hypogea Mart., B 4030, VP

BIGNONIACEAE

Anemopaegma arvense (Vell.) Stellfeld ex de Souza, B 2883, H
Anemopaegma glaucum Mart. ex A. DC., B 3035, H
Anemopaegma scabriusculum Mart. ex A. DC., B 1938, H
Arrabidaea brachypoda (A. DC.) Bur., B 2272, Ch
Arrabidaea pulchra (Cham.) Sandw., B 2460, Li
Cybistax antisyphilitica Mart., B 3246, Ph
Jacaranda caroba (Vell.) A. DC., B 2279, Ch
Jacaranda decurrens Cham., B 3799, Ch
Jacaranda rufa Silva Manso, B 2267, Ch
Memora pedunculata (Vell.) Miers, B 2063, Ch
Tabebuia aurea (Silva Manso) S. Moore, B 3557, Ph
Tabebuia ochracea (Cham.) Standl., B 3659, Ph
Zeyheria montana Mart., B 2661, Ph

BORAGINACEAE

Cordia villicaulis Fresen., B 3811, H

BROMELIACEAE

Aechmea bromeliifolia (Rudge) Baker, B 2474, Ep
Ananas ananassoides L.B. Sm., B 2878, H
Bilbergia magnifica Mez, B 3755, Ep
Bromelia balansae Mez, B 2013, H
Dickia tuberosa (Vell.) Beer, B 2839, H

BURSERACEAE

Protium ovatum Engl., B 1930, Ph

CACTACEAE

Epiphyllum phyllanthus (L.) Haw., B 3878, Ep

CARYOCARACEAE

Caryocar brasiliense Cambess., B 1989, Pn

CARYOPHYLLACEAE

Polycarpaea corymbosa (L.) Lam., B 3359, Th

CELASTRACEAE

Plenckia populnea Reissek, B 2277, Ph
Tontelea micrantha (Mart.) A.C. Sm., B 1934, Ph

CHRYSOBALANACEAE

Couepia grandiflora (Mart. & Zucc.) Benth. ex Hook. f., B 3717, Ph
Licania humilis Cham. & Schltdl., B 3034, Ph
Parinari excelsa Sabine, B 1978, Ch

CLUSIACEAE

Kielmeyera abdita Saddi, B 2095, Ch
Kielmeyera coriacea Mart., B 2119, Ph
Kielmeyera grandiflora (Wawra) Saddi, B 2061, Ph
Kielmeyera rubriflora Cambess., B 3022, Ph
Kielmeyera trichophora Mart., B 2035, Ch
Kielmeyera variabilis Mart., B 1915, Ch

COCHLOSPERMACEAE

Cochlospermum regium (Mart.) Pilg., B 2428, H

COMBRETACEAE

Buchenavia tomentosa Eichl., B 4031, Ph
Combretum hilarianum D. Dietr., B 2133, Cn

COMMELINACEAE
Commelina obliqua Vahl, B 2060, Th

CONNARACEAE
Connarus suberosus Planch., B 2374, Ph
Rourea induta Planch., B 1931, Ph

CONVOLVULACEAE
Evolvulus cressoides Mart., B 2917, H
Evolvulus fuscus Meisn., B 3974, H
Evolvulus macroblepharis Mart., B 3252, H
Ipomoea argentea Meisn., B 2651, H
Ipomoea campestris Meisn., B 3524, H
Ipomoea procumbens Mart. ex Choisy, B 2613, H
Ipomoea procurrens Meisn., B 2295, Li
Ipomoea sp. nov., B 2357, H
Ipomoea virgata Meisn., B 3415, H
Jacquemontia guaranitica Hassl., B 2636, H
Jacquemontia sphaerocephala Meisn., B 2363, H
Merremia contorquens (Choisy) Hall. f., B 2600, Li
Merremia digitata Meisn., B 2140, Li
Turbina abutiloides (Kunth) O'Donnell, B 2512, H
Convolvulaceae sp. 1, gen. et sp. nov., B 1967, H

CUCURBITACEAE
Cayaponia espelina Cogn., B 2118, Li
Ceratosanthes hilariana Cogn., B 3645, Li
Melancium campestre Naud., B 2608, H

CYPERACEAE
Bulbostylis junciformis (Kunth) C.B.Clarke, B 2300, H
Bulbostylis paradoxa (Spreng.) Lindm., B 3565, H
Bulbostylis sphaerocephala (Nees) C.B. Clarke, B 2046, H
Bulbostylis truncata (Nees) M.T. Strong, B 3971, H
Cyperus aggregatus (Willd.) Endl., B 2023, H
Cyperus meyenianus Kunth, B 2707, H
Kyllinga odorata Vahl, B 2931, H
Rhynchosphora diamantina (C.B.Clarke) Kükenth, B 2316, H
Rhynchosphora emaciata Boeck., B 3087, H
Rhynchosphora exaltata Kunth, B 2466, H
Rhynchosphora rugosa (Vahl) Gale, B 3534, H
Scleria scabra Willd., B 2310, H

DILLENIACEAE
Davilla elliptica A. St-Hil., B 2080, Ph
Davilla nitida (Vahl) Kubitzki, B 3988, Li

DIOSCOREACEAE
Dioscorea amaranthoides Presl, B 3124, Li
Dioscorea claussenii Uline, B 3044, Li

EBENACEAE
Diospyros hispida A. DC., B 2031, Ph

ERYTHROXYLACEAE
Erythroxylum campestre A. St-Hil., B 2228, Ph
Erythroxylum deciduum A. St-Hil., B 3716, Ph
Erythroxylum suberosum A. St Hil., B 1965, Ph

EUPHORBIACEAE
Chamaesyce caecorum (Mart. ex Boiss.) Croizat, B 2137, H
Cnidosculus quercifolius Pohl, B 1946, H
Croton aberrans Müll. Arg., B 2036, H
Croton antisyphiliticus Mart., B 2017, H
Croton cinctus Müll. Arg., B 3109, H
Croton glandulosus Müll. Arg., B 2389, H
Croton goyazensis Müll. Arg., B 2222, H
Croton lundianus Müll. Arg., B 2205, H
Croton pohlianus Müll. Arg., B 2196, H
Croton sclerocalyx Müll. Arg., B 2885, H
Croton sp., B 1964, H
Dalechampia humilis Müll. Arg., B 1981, H
Dalechampia linearis Baill., B 2076, H
Julocroton humilis Didr., B 2207, H
Manihot caerulescens Pohl, B 2459, H
Manihot tripartita (Spreng.) Müll. Arg., B 1908, H
Maprounea guianensis Aubl., B 3930, Ph
Phyllanthus orbiculatus Müll. Arg., B 2445, Th
Sapium glandulatum (Vell.) Pax, B 2301, Ch
Sebastiania bidentata (Mart.) Pax, B 2430, H

FABACEAE
Acosmium subelegans (Mohl.) Yakovlev, B 3815, Ph
Aeschynomene marginata Benth., B 2716, Th
Aeschynomene oroboides Benth., B 2055, H
Anadenanthera falcata (Benth.) Speg., B 2650, Ph
Andira cuiabensis Benth., B 2045, Ph
Andira laurifolia Benth., B 2342, Ch
Andira vermifuga (Mart.) Benth., B 3718, Ph
Arachis tuberosa Bong. ex Benth., B 2275, H
Bauhinia rufa Steud., B 1907, Ph
Bowdichia virgilioides Kunth, B 3350, Ph
Calliandra dysantha Benth., B 1979, Ch
Calliandra macrocalyx Harms, B 2230, Ph
Calopogonium sericeum (Benth.) Chodat ex Hassl., B 2569, Li
Camptosema ellipticum (Desv.) Burkart, B 3232, Li
Centrosema venosum Mart. ex Benth., B 1924, Li
Chamaecrista basifolia (Vogel) Irwin & Barneby, B 2710, Ch

Chamaecrista campestris Irwin & Barneby, B 2723, Ch
Chamaecrista cotonifolia (G. Don) Killip, B 4001, Ch
Chamaecrista desvauxii (Collad.) Killip, 2457, Ch
Chamaecrista filicifolia (Benth.) Irwin & Barneby, B 2325, Ch
Chamaecrista flexuosa (L.) Greene, B 2290, Ch
Chamaecrista lundii (Benth.) Irwin & Barneby, B 3435, H
Chamaecrista nictitans (L.) Moench., B 2726, Ch
Chamaecrista planaltoana (Harms) Irwin & Barneby, B 2208, H
Chamaecrista rotundifolia (Pers.) Greene, B 1974, H
Chamaecrista setosa (Vogel) Irwin & Barneby, B 2725, Ch
Clitoria densifolia (Presl) Benth., B 2433, H
Copaifera langsdorffii Desf., B 2127, Ph
Crotalaria maypurensis Kunth, B 2597, Th
Crotalaria nitens Benth., B 2724, H
Crotalaria velutina Benth., B 2881, H
Dalbergia cuiabensis Benth., B 3214, Ph
Dalbergia miscolobium Benth., B 3504, Ph
Desmodium barbatum (L.) Benth., B 3024, H
Desmodium incanum (Sw.) A. DC., B 2523, Th
Desmodium platycarpum Benth., B 3944, H
Dimorphandra mollis Benth., B 2047, Ph
Dioclea bicolor Benth., B 2042, Li
Diptychandra aurantiaca Tul., B 3056, Ph
Eriosema crinitum (Kunth) Gardner, B 2483, H
Eriosema cupreum Harms, B 2120, H
Eriosema glabrum Mart. ex Benth., B 2251, H
Eriosema heterophyllum Benth., B 3992, H
Eriosema longifolium Benth., B 2194, H
Eriosema rufum Kunth, B 2444, H
Galactia decumbens (Benth.) Chodat & Hassl., B 2371, H
Galactia dimorpha Burk., B 2130, H
Galactia martii A. DC., B 3512, H
Harpalyce brasiliana Benth., B 2548, Ph
Hymenaea stigonocarpa Mart., B 2326, Pn
Indigofera gracilis Bong., B 2057, H
Lupinus subsessilis Benth., B 2320, H
Machaerium acutifolium Vogel, B 2115, Ph
Mimosa amnis-atri Barneby, B 3589, Ph
Mimosa distans Benth., B 2070, Ch
Mimosa foliolosa Benth., B 2367, Ph
Mimosa gemmulata Barneby, B 2012, Ph
Mimosa gracilis Benth., B 2395, Ch
Mimosa hebecarpa Benth., B 1911, Ph
Mimosa nuda Humb. & Bonpl., B 2074, H
Mimosa polycephala Benth., B 2391, Ch
Mimosa radula Benth., B 2452, Ch
Mimosa xanthocentra Mart., B 2114, Ch
Periandra mediterranea (Vell.) Taub., B 2671, Ch
Phaseolus firmulus Mart., B 3488, H
Plathymenia reticulata Benth., B 3977, Ph
Poiretia angustifolia Vogel, B 2386, H
Poiretia latifolia Vogel, B 3007, H
Poiretia longipes Harms, B 2599, H
Pterodon pubescens Benth., B 3833, Ph
Rhynchosia platyphylla Benth., B 2653, H
Senna rugosa (G. Don.) Irwin & Barneby, B 2329, Ph
Senna silvestris (Vell.) Irwin & Barneby, B 2314, Ph
Senna velutina (Vogel) Irwin & Barneby, B 3032, Ph
Stryphnodendron adstringens (Mart.) Coville, B 1985, Ph
Stryphnodendron obovatum Benth., B 2087, Ph
Stylosanthes bracteata Vogel, B 2155, H
Stylosanthes gracilis Kunth, B 2562, Th
Stylosanthes guianensis Sw., B 2423, Th
Stylosanthes scabra Vogel, B 3323, H
Tephrosia adunca Benth., B 2258, H
Vatairea macrocarpa (Bentn.) Ducke, B 4032, Ph
Vigna linearis Kunth, B 2838, Li
Zornia latifolia Sm., B 2676, H
Zornia reticulata Sm., B 2481, H
Zornia virgata Moric., B 3142, H
Fabaceae sp. 1, B 2796, Ph

FLACOURTIACEAE

Casearia grandiflora Cambess., B 2078, Ph
Casearia sylvestris Sw., B 2473, Ph
Casearia sp., B 2034, H

GENTIANACEAE

Deianira nervosa Cham. & Schltdl., B 3457, H
Irlbachia alata (Aubl.) Maas, B 2879, H
Irlbachia speciosa (Cham. & Schltdl.) Maas, B 3438, H

GESNERIACEAE

Sinningia elatior (Kunth) Chautems, B 3989, H

HYPOXIDACEAE

Curculigo sp., B 4019, Geo

ICACINACEAE

Emmotum nitens (Benth.) Miers, B 3244, Ph

IRIDACEAE

Sisyrinchium vaginatum Spreng. B 2253, Geo
Trimezia juncifolia (Kl.) Kunth, B 2062, Geo

LAMIACEAE

Eriope crassipes Benth., B 2054, H
Hypenia macrantha (A. St-Hi.. ex Benth.) Harley, B 3704, H
Hyptidodendron canum (Pohl ex Benth.) Harley, B 3493, Ph
Hyptis adpressa A. St-Hil. ex Benth., B 4013, H
Hyptis capriariifolia Pohl ex Benth., B 3006, H
Hyptis caudata Epling & Sativa, B 3643, H
Hyptis crinita Benth., B 3334, H
Hyptis desertorum Pohl ex Benth., B 4015, H
Hyptis eriophylla Pohl, B 2849, H
Hyptis ferruginosa Pohl ex Benth., B 3979, H
Hyptis interrupta Pohl ex Benth., B 3076, H
Hyptis lythroides Pohl ex Benth., B 3708, H
Hyptis multiflora Pohl ex Benth., B 2670, H
Hyptis recurvata Poit. B 3535, H
Hyptis saxatilis A. St-Hil. ex Benth., B 3111, Ch
Hyptis villosa Poh. ex Benth., B 2255, H
Hyptis virgata Benth., B 1925, H
Hyptis sp., B 3544, H
Marsypianthes chamaedrys (Vahl) Kuntze, B 2531, H
Marsypianthes montana Benth., B 3108, H
Ocimum sp., B 2151, H
Peltodon pusillus Pohl, B 3271, H
Peltodon tomentosus Pohl, B 3065, H
Salvia sp., B 2100, H

LAURACEAE

Aiouea trinervis Meisn., B 3931, Ph
Cassytha filiformis L., B 2422, VP

LECYTHIDACEAE

Eschweilera nana (O. Berg) Miers, B 2825, Ph

LOGANIACEAE

Strychnos pseudoquina A. St Hil., B 3943, Ph

LYTHRACEAE

Cuphea carthagenensis (Jacq.) Macbr., B 2179, H
Cuphea linarioides Koenne, B 2136, H
Lafoensia pacari A. St Hil., B 3782, Ph

MALPIGHIACEAE

Banisteriopsis acerosa (Nied.) B. Gates, B 2809, Ph
Banisteriopsis amplectens B. Gates, B 2429, Li
Banisteriopsis campestris (A. Juss.) Little, B 2346, Li
Banisteriopsis gardneriana (A. Juss.) W. Anderson & Sattl., B 3756, Li
Banisteriopsis laevifolia (A. Juss.) B. Gates, B 2558, Li
Banisteriopsis schizoptera (A. Juss.) B. Gates, B 3049, Li
Banisteriopsis stellaris (Griseb.) B. Gates, B 2479, L
Banisteriopsis variabilis B. Gates, B 2304, Li
Byrsonima basiloba A. Juss., B 2133, Ph
Byrsonima coccolobifolia A. Juss., B 2233, Ph
Byrsonima crassa Nied., B 1898, Ph
Byrsonima gaultherioides Griseb., B 2898, Ch
Byrsonima guilleminiana A. Juss., B 2044, Ch
Byrsonima intermedia A. Juss., B 2467, Ph
Byrsonima rigida A. Juss., B 2135, Ch
Byrsonima verbascifolia (Griseb.) B. Gates, B 2643, Ph
Camarea affinis A. St-Hil., B 2417, H
Heteropterys anoptera A. Juss., B 3149, Li
Heteropterys byrsonimifolia A. Juss., B 2476, Ph
Heteropterys campestris A. Juss., B 2172, Li
Heteropterys coriacea A. Juss., B 3089, Li
Peixotoa reticulata Griseb., B 2079, Li
Tetrapteris ambigua (A. Juss.) Nied., B 3279, Li

MALVACEAE

Byttneria oblongata Pohl, B 2129, H
Eriotheca gracilipes (K. Schum.) A. Robyns, B 1936, Ph
Eriotheca pubescens (Mart. & Zucc.) A. Robyns, B 3336, Ph
Helicteres sacarolha A. St-Hil., B 2468, H
Krapovichasia macrodon (A. DC.) Fryxell, B 2175, H
Melochia villosa (Mill.) Fawc. & Rendle, B 2499, H
Pavonia rosa-campestris A. St-Hil., B 1962, H
Peltaea edouardii (Hochr.) Krapov. & Cristóbal, B 1940, H
Peltaea polymorpha (A. St-Hil.) Krapov. & Cristóbal, B 2528, H
Pseudobombax longiflorum (Mart. & Zucc.) A. Robyns, B 3507, Ph
Sida cerradoensis Krapov., B 2960, H
Sida cordifolia L., B 2961, H
Sida linearifolia A. St-Hil., B 3051, H
Sida rhombifolia L. *, B 2840, H
Waltheria douradinha A. St Hil. B 2028, H
Waltheria indica L. *, B 2274, H

MELASTOMATACEAE

Miconia albicans Triana, B 1987, Ph
Miconia fallax A. DC., B 1986, Ph
Miconia ferruginata A. DC., B 1988, Ph
Miconia ligustroides (A. DC.) Naud., B 3465, Ph

Miconia rubiginosa (Bonpl.) A. DC., B 1956, Ph
Mouriri elliptica Mart., B 2131, Ph
Rhynchanthera ursina Naud., B 3536, Ch
Tibouchina gracilis (Bonpl.) Cogn., B 2635, Ch
Tibouchina stenocarpa (A. DC.) Cogn., B 2800, Ph

MENISPERMACEAE
Cissampelos ovalifolia Ruíz & Pav., B 1954, H

MORACEAE
Brosimum gaudichaudii Trècul, B 2109, Ph

MYRISTICACEAE
Virola sebifera Aubl., B 3219, Ph

MYRSINACEAE
Myrsine leuconeura Mart., B 2820, Ph

MYRTACEAE
Campomanesia adamantium (Cambess.) O.Berg, B 1929, Ph
Campomanesia pubescens (A. DC.) O. Berg, B 2226, Ph
Eugenia angustissima O. Berg, B 2413, H
Eugenia aurata O. Berg, B 2699, Ph
Eugenia bimarginata A. DC., B 3502, Ph
Eugenia calycina Cambess., B 2618, Ch
Eugenia complicata O. Berg, B 3583, Ch
Eugenia cristaensis O. Berg, B 2231, H
Eugenia piauhiensis O. Berg, B 2025, Ph
Eugenia piloesis Cambess., B 2511, Ph
Eugenia punicifolia (Kunth) A. DC., B 2265, Ph
Eugenia sp. 1, B 4017, Ch
Eugenia sp. 2, B 3601, Ph
Eugenia sp. 3, B 2237, H
Eugenia sp. 4, B 2923, Ch
Myrcia bella Cambess., B 2127, Ph
Myrcia bracteata O. Berg, B 2673, Ph
Myrcia camapuanensis N.F.E. Silveira, B 1966, Ph
Myrcia crassifolia (O. Berg) Kiaersk., , B 2228, Ph
Myrcia decrescens O. Berg, B 1994, Ph
Myrcia fallax (Rich.) A. DC., B 3689, Ph
Myrcia guianensis A. DC., B 3691, Ph
Myrcia laruotteana Cambess., B 3927, Ph
Myrcia lasiopus O. Berg, B 2689, H
Myrcia linguaeformis Kiaersk., B 3555, Ph
Myrcia rhodeosepala Kiaersk., B 3817, Ph
Myrcia torta A. DC., B 3723, Ch
Myrcia uberavensis O. Berg, B 3561, Ph
Myrcia variabilis Mart. ex A. DC., B 2041, Ph
Myrcia sp. 1, B 2238, Ch
Myrcia sp. 2, B 3260, Ph
Myrcia sp. 3, B 3442, H
Myrciaria delicatula (A. DC.) O. Berg, B 2995, H
Psidium australe Cambess. B 2777, Ch
Psidium cinereum Mart., B 2212, Ch
Psidium firmum O. Berg, B 3848, Ch
Psidium laruotteanum Cambess., B 2250, Ph
Psidium multiflorum Cambess., B 2547, Ch
Psidium rufum Mart. ex A. DC., B 2199, Ph

NYCTAGINACEAE
Guapira campestris (Netto) Lund., B 3969, Ch
Guapira gracilifora (Mart. ex J.A. Schmidt) Lund., B 3929, Ph
Guapira noxia (Netto) Lund., B 3552, Ph
Neea macrophylla Poepp. & Endl., B 3080, Ph
Neea theifera Oerst., B 2110, Ph

OCHNACEAE
Ouratea acuminata (A. DC.) Engl., B 2463, Ph
Ouratea castaneaefolia (A. DC.) Engl., B 3577, Ph
Ouratea floribunda (A. St-Hil.) Engl., B 2219, Ch
Ouratea nana (A. St-Hil.) Engl., B 2462, Ch
Ouratea spectabilis (Mart.) Engl., B 2045, Ph

ORCHIDACEAE
Epistephium sclerophyllum Lindl., B 2830, Geo
Galeandra montana Barb. Rodr., B 2727, Geo
Habenaria brevidens Lindl., B 2811, Geo
Habenaria nasuta Rchb. f. & Warm., B 2751, Geo
Habenaria obtusa Lindl., B 2633, Geo

OXALIDACEAE
Oxalis sellowii Spreng., B 1910, H

PASSIFLORACEAE
Mitostemma brevifilis Gontsch., B 3562, Ch
Passiflora mansoi (Mart.) Mast., B 3066, Li

POACEAE
Actinocladum verticillatum (Nees) McClure ex Soderstrom, B 3837, Ph
Andropogon bicornis L., B 2866, H
Andropogon fastigiatus Sw., B 3157, H
Andropogon leucostachys Kunth, B 1922, H
Andropogon selloanus (Hack.) Hack., B 2614, H
Anthaenantiopsis perforata (Nees) Parodi, B 2344, H
Apoclada arenicola McClure, B 3855, Ph
Aristida longifolia Trin., B 3233, H
Aristida riparia Trin., B 2560, H
Axonopus aureus P. Beauv., B 3017, H
Axonopus barbigerus (Kunth) Hitchc., B 2763, H
Axonopus brasiliensis (Spr.) Kuhlm., B 2890, H
Axonopus derbyanus Black, B 2291, H
Brachiaria decumbens Stapf *, B 2311, H

Ctenium chapadense (Trin.) Doell., B 3420, H
Echinolaena inflexa (Poir.) Chase, B 2382, H
Elionurus latiflorus Nees, B 3770, H
Eragrostis articulata (Schrank) Nees, B 2556, Th
Eragrostis maypurensis (Kunth) Steud., B 2170, Th
Gymnopogon foliosus (Willd.) Nees, B 3083, H
Hyparrhenia bracteata (Humb. & Bonpl.) Stapf, B 3833, H
Hyparrhenia rufa (Nees) Stapf *, B 3181, H
Ichnanthus procurrens (Nees) Sw., B 2561, H
Leptocoryphium lanatum (Kunth) Nees, B 3700, H
Loudetiopsis chrysothryx (Nees) Conert, B 2845, H
Melinis minutiflora P. Beauv. *, B 2278, H
Olyra taquara Sw., B 3949, Ph
Panicum olyroides Kunth, B 1928, H
Panicum rudgei Roem. & Shult., B 2491, H
Panicum sp., B 2969, H
Paspalum carinatum Humb. & Bonpl. ex Fleug., B 2002, H
Paspalum convexum Humb. & Bonpl. ex Fleug., B 2972, H
Paspalum erianthum Nees, B 2405, H
Paspalum gardnerianum Nees, B 2354, H
Paspalum geminiflorum Steud., B 3250, H
Paspalum malacophyllum Trin., B 3050, H
Paspalum multicaule Poir., B 3168, H
Paspalum pectinatum Nees, B 2343, H
Paspalum sp. 1, B 3060, H
Paspalum sp. 2, B 2938, H
Pennisetum setosum (Sw.) L. C. Rich. *, 3363, H
Rhynchelytrum repens (Nees) C.E. Hubb. *, B 2572, Th
Schizachyrium condensatum (Kunth) Nees, B 3430, H
Setaria geniculata (L.) P. Beauv. *, B 2495, Th
Sporobolus acuminatus Boechat & Longhi Wagner, B 2181, H
Sporobolus ciliatus (Trin.) Hack., B 2986, H
Sporobolus indicus (L.) R. Brown, B 2519, H
Sporobolus tenuissimus (Schrank) Kuntze, B 2178, T
Thrasya petrosa Nees, B 2630, H
Tristachya leiostachya Nees, B 2269, H

POLYGALACEAE

Polygala angulata A. DC., B 2425, H
Polygala aphylla A.W. Benn., B 3910, H
Polygala opina Wurdack, B 2223, H
Polygala violacea Aubl., B 2492, H
Securidaca tomentosa A. St-Hil., B 3547, Li

POLYGONACEAE

Coccoloba densifions Mart. ex Meisn., B 2111, Ph

POLYPODIACEAE

Adiantum serratodentatum Humb. & Bonpl. ex Willd., B 3403, H

PROTEACEAE

Roupala montana Aubl., B 2144, Ph

RHAMNACEAE

Crumenaria polygaloides Reissek, B 2920, H

RUBIACEAE

Alibertia sessilis (Vell.) K. Schum., B 2108, Ch
Borreria suaveolens Meyers, B 1914, H
Chomelia ribesioides Benth. ex A. Gray, B 3928, Ph
Declieuxia fruticosa (Willd.) Kuntze, B 2138, H
Declieuxia oenanthoides Schult. & Schult., B 2040, H
Declieuxia verticillata Müll. Arg., B 2245, H
Diodia schumannii Standl., B 1972, Th
Diodia teres Walt., B 2524, Th
Galianthe grandifolia E.L. Cabral, B 2944, H
Genipa americana L., B 2449, Ph
Palicourea coriacea (Cham.) K. Schum., B 1903, Ch
Palicourea rigida Kunth, B 1941, Ph
Richardia humistrata (Cham. & Schltdl.) Steud., B 1909, H
Richardia stellaris (Cham. & Schltdl.) Steud., B 3036, H
Sipanea hispida Benth., B 2485, H
Tocoyena formosa (Cham. & Schltdl.) K. Schum., B 2124, Ph

RUTACEAE

Hortia brasiliensis Vand. ex A. DC., B 2765, Ph
Spiranthera odoratissima A. St-Hil., B 2073, Ch

SAPINDACEAE

Matayba guianensis Aubl., B 3925, Ph
Serjania cissoides Radlk., B 1993, Li
Serjania erecta Radlk., B 2128, Ch
Serjania reticulata Cambess., B 3040, Li
Talisia angustifolia Radlk., B 1935, Ch
Toulicia tomentosa Radlk., B 3088, Ch

SAPOTACEAE

Pouteria ramiflora (Mart.) Radlk., B 1984, Ph
Pouteria subcaerulea Pierre ex Dubard, B 1899, Ch
Pouteria torta (Mart.) Radlk., B 1918, Ph
Pradosia brevipes (Pierre) Penn., B 3772, H

SCROPHULARIACEAE

Buchnera lavandulacea Cham. & Schltdl., B 2437, H

Esterhazya petiolata Barr., B 3358, H
Scoparia dulcis L.*, B 2486, Ch

SIMAROUBACEAE
Simaba suffruticosa Engl., B 3730, Ch
Simarouba amara Aubl., B 3802, Ph

SMILACACEAE
Smilax cissoides Mart. ex Griseb., B 2330, Li

SOLANACEAE
Solanum lycocarpum A. St-Hil., B 2020, Ph
Solanum subumbellatum Vell., B 4005, Ch

STYRACACEAE
Styrax ferrugineum Nees & Mart., B 3227, Ph

TURNERACEAE
Piriqueta emasensis Arbo, sp. nov., B 1968, H
Piriqueta sidifolia (Cambess.) Urban, B 3059, Ch
Turnera purpurascens Arbo, B 2359, H

VERBENACEAE
Aegiphila lanata Mold., B 2303, Ch
Aegiphila lhotzkiana Cham., B 2315, Ph
Amasonia hirta Benth., B 2385, H
Casselia chamaedryfolia Cham., B 2066, H
Lippia hirta Schauer, B 2415, Ch
Lippia hoehnei Mold., B 3690, Ch
Lippia lupulina Cham., B 3642, Ch
Lippia martiana Schauer, B 2254, Ch
Lippia primulina S. Moore, B 3966, H
Lippia stachyoides Cham., B 2257, H
Lippia turnerifolia Cham., B 2505, H
Stachytarpheta maximilliani Schauer, B 2401, H
Stachytarpheta simplex Hayek, B 2369, H

VIOLACEAE
Hybanthus poaya (A. St-Hil) Baill., B 3947, H
Hybanthus sp. nov., B 3513, H

VITACEAE
Cissus erosa L.C. Rich, B 2458, Li

VOCHYSIACEAE
Qualea grandiflora Mart., B 2065, Ph
Qualea multiflora Mart., B 2434, Ph
Qualea parviflora Mart., B 3952, Ph
Vochysia thyrsoidea Pohl, B 2892, Ph
Vochysia tucanorum Mart., B 2496, Ph

Unknown
Unknown sp. 1, B 2305, Ch

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BOOK REVIEW

IRWIN M. BRODO, SYLVIA DURAN SHARNOFF, and STEPHEN SHARNOFF. 2001. **Lichens of North America.** (ISBN 0-300-08249-5, hbk.). Yale University Press, 302 Temple Street, P.O. Box 209040, New Haven, CT 06520-9040, U.S.A. (Orders: 203-432-0960, 203-432-0948 fax). $69.95, 795 pp, 924 color photos, distribution maps, 9 1/2" × 11".

This recently published magnum opus *Lichens of North America* is a beautiful volume that treats an often overlooked group of organisms. And this book has everything! The book is divided into two parts. The first part begins with introductory material including a wonderful description of the symbiotic relationships that lichens form and moves on to discuss lichen morphology, anatomy, reproduction, physiology, chemistry, ecology and biogeography. Two chapters describe how humans have found uses for lichens and how we may use them as environmental indicators. There are also two chapters offering very practical information on how to describe and classify lichens and how to collect and preserve them for future study. The final chapter in the first part of the book provides useful information about how to use the maps, keys and descriptions in the second half of the book

The second part of this volume provides easy to follow keys, well crafted descriptions, beautiful photographs, and very useful range maps for 805 species of lichens. The photographs and range maps should make this volume extremely useful for anyone interested in lichens whether they be professionals or avocational enthusiasts. A comprehensive glossary in the back of the book provides a most welcome guide to the terminology associated with a group of organisms about which many people know very little.

The introductory text in this book is extremely well written and immensely readable. And the photographs are simply works of art. This captivating and thoroughly engrossing book should be on the shelf of everyone who loves nature, and can appreciate the wonderful diversity to be found even in one of the least well-known and overlooked groups of organisms. It will surely inspire many of us to take a closer look the next time we see a lichen.—*Debra Trock, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

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RUST FUNGI (UREDINALES) OF NORTHWEST ARGENTINA

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ABSTRACT

This paper presents the results of a study of rust fungi (Uredinales) on wild and cultivated plants in the provinces of Catamarca, Jujuy, Salta and Tucumán that belong to the region known as Northwest Argentina. The rust fungi are represented by 635 collections on 257 host plant species belonging to 51 vascular plant families. These rusts constitute 182 species in 30 genera of which 61 are new records for Argentina and 10 are new species of rusts. Eighty-four of the collections represent new host records for Argentina, and 50 of these are new host records for rusts. Specimens have been deposited in either Fundación Miguel Lillo (LIL) or the U.S. National Fungus Collection (BPI).

RESUMEN

En el presente trabajo se presentan los resultados de la prospección de royas (Uredinales) realizada sobre la flora silvestre y cultivada de las Provincias de Catamarca, Jujuy, Salta, y Tucumán, pertenecientes a la región conocida como Noroeste Argentino. Como resultado de este trabajo se elaboraron 635 colecciones correspondientes a 51 familias de hospedantes (257 especies). Ochenta y cuatro de estas colecciones son nuevos hospedantes para Argentina, de las cuales 50 son nuevas citas como hospedantes para royas. Se identificaron 30 géneros y 182 especies de royas, de las cuales 61 son nuevos registros para el país y 10 nuevas especies. Las colecciones fueron depositadas en Fundación Miguel Lillo (LIL) y U.S. National Fungus Collection (BPI).

The fungi of Argentina have been studied by a number of mycologists, most notably Carlos Luigi Spegazzini (1858–1926) whose taxa were compiled into a comprehensive account by Farr (1973). Spegazzini's collections of rust fungi (Uredinales) as well as collections made by later mycologists were organized and studied by Lindquist (1982). Lindquist's studies resulted in numerous publications on rust fungi, culminating in his "Royas de la República Argentina y Zonas Limítrofes" (Lindquist 1982). Although the fungi of Argentina are relatively well known, the rust fungi of Northwest Argentina are less well studied because few mycologists collected rusts in that region.

In this paper we present a study of rust fungi collected on wild and cultivated plants in the provinces of Catamarca, Jujuy, Salta and Tucumán in Northwest Argentina. This subtropical region is characterized by climatic and biological diversity and consists of a plain in the east and the Cordillera de los Andes in the west where valleys closely alternate with mountains. The gradations in latitude and altitude in Northwest Argentina result in a mosaic of bioecosystems with vegetation types varying from desert to rain forest. The diversity of flora is reflected in the range of phytogeographical regions described

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for this area by Cabrera (1994). For these reasons, Northwest Argentina is an interesting and rich area for collecting rust fungi.

Lindquist (1982) documented 450 species representing 28 genera of rust fungi from throughout Argentina of which 124 species were reported from Northwest Argentina. Between 1993 and 1999 the authors collected and identified or re-examined 635 specimens of rust fungi representing 182 species in 30 genera. These rust specimens were collected on 257 host plant species from 51 plant families. Eighty-four of these host plants are new host records for Argentina, and 50 of these are new host records for rusts worldwide. Sixty-one rust species are reported for the first time from Argentina and 10 of these are new species. One of those, *Baeodromus ranunculi* J.R. Hern. & J.F. Hennen, has been described (Hernández 2000) and the remainder will be described elsewhere.

RESULTS

The rust species reported here are presented according to host family. This is the most useful form of organization because of the high level of host specificity of the rust fungi. Collections for each rust species are then listed alphabetically by host species followed by the province, details of locality, date, collector(s) and collector's number, herbarium number and rust stage present. For the rust stages symbols are used as follows: 0 = spermogonial stage, I = aecial stage, II = uredinial stage, and III = telial stage. The abbreviation "An" refers to the presence of an anamorph stage for which we are uncertain whether it is functionally an aecial or uredinial stage. Symbols representing spore types are X = amphispores, M = mesospores, and IV = basidiospores.

New rust records are indicated in superscript following the species name as follows: new rust species (N), new rust record for Argentina (A), Catamarca (C), Jujuy (J), Salta (S), and Tucumán (T). Superscript notations following host names indicate: new host plant genus for this rust worldwide (G), new host plant species for this rust worldwide (S), new host plant species for any rust in Argentina (A), and new host plant species for which another rust was previously known from Argentina (AR).

Abbreviations of authorities for plant host and fungal names follow Brummit and Powell (1992) and Kirk and Ansell (1992) respectively. Plant host names were verified using W3TROPICOS at the Missouri Botanical Garden.

ACANTHACEAE

Aecidium sp.[N]

on *Dyschoriste* sp.[G]; **Salta:** Quebrada de San Lorenzo, 6 Dec 1997, *J.R.Hernández 97-162* (BPI 841258) [I]. **Tucumán:** 22 km W of San Miguel de Tucumán, mtn, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-019* (LIL 54702, BPI 840996) [I].

Puccinia justiciae Puttemans

on *Chaetothylax umbrosus* Nees[G]; **Tucumán:** San Pedro de Colalao, 2 Apr 1994, *J.F.Hennen & M.M.Hennen 94-069* (LIL 54706, BPI 841031) [II].

Puccinia lateripes Berk. & Ravenel[A]

on *Ruellia ciliatiflora* Hook.[S]; **Tucumán:** Dept. Trancas, Vipos, 30 Mar 1995, *J.R.Hernández 95-043* (BPI 841086) [II-

III]; Las Salas, 5 May 1995, *J.R.Hernández 95-015* (BPI 841079) [I-II-III]; San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-150* (LIL 54704, BPI) [II-III]; San Pedro de Colalao, 2 Apr 1994, *J.F.Hennen & M.M.Hennen 94-071* (LIL 54703, BPI) [0].

Puccinia sp.

on *Ruellia erythropus* (Nees) Lindau[A]; **Catamarca:** E of La Viña, 24 Sep 1997, *J.F.Hennen & J.R.Hernández 97-061* (BPI 841197) [II].

Puccinia thunbergiae Cooke[A]

on *Justicia* sp.; **Tucumán:** San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-144* (LIL 54705, BPI 841067) [II-III].

Uromyces sp.[A]

on *undtn.*; **Jujuy:** Palma Sola, 12 Apr 1994, *J.F.Hennen & L.D.Ploper 94-127* (LIL 54707, BPI 841056) [III].

AMARANTHACEAE

Uromyces bonaerensis Speg.

on *Gomphrena elegans* Mart.; **Tucumán:** Cruz Alta, 28 Jul 1913, leg. ? [II].

Uromyces celosiae Dietel & Holw.[A]

on *Chamissoa altissima* (Jacq.) Kunth[A]; **Tucumán:** San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-165* (LIL 54708, BPI 841074) [II].

Uromyces iresines Lagerh. ex Syd. & P. Syd.[A]

on *Iresine diffusa* Humb. & Bonpl. ex Willd. var. *diffusa*[A]; **Tucumán:** San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-140* (LIL 54709, BPI 841064) [III].

ANNONACEAE

Phakopsora neocherimoliae (Cummins) Buriticá & J.F. Hennen[A]

on *Annona cherimolia* Mill.; **Tucumán:** Dept. Capital, 15 Sep 1995, *J.R.Hernández 95-088* (BPI 841111) [II]; Dept. Famailla, Sauce Huascho, 23 Apr 1993, *N.E.V.de Ramallo s.n.* (BPI) [II].

APIACEAE

Puccinia hydrocotyles Cooke[C,S]

on *Hydrocotyle bonariensis* Comm. ex Lam.[A]; **Buenos Aires:** La Plata, 29 Sep 1997, *J.F.Hennen & J.R.Hernández 97-072* (BPI) [II]. **Catamarca:** N of Catamarca, Hwy. 38, 24 Sep 1997, *J.F.Hennen & J.R.Hernández 97-054* (BPI) [II]; road to El Rodeo, camping area, 29 Nov 1997, *J.R.Hernández 97 117* (BPI) [II]; W of Catamarca, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-043* (BPI) [II]; W side of Catamarca, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-035* (BPI 841184) [II]. **Salta:** Dept. Santa Victoria, La Misión, 30 Jun 1996, *J.R.Hernández 96-059* (BPI) [II]. **Tucumán:** Lules, Aug 1994, *J.R.Hernández 94-149* (LIL 54943, BPI) [II].

on *Hydrocotyle* sp.; **Catamarca:** El Rodeo, 29 Nov 1997, *J.R.Hernández 97-121* (BPI) [II]. **Tucumán:** Amberes, 5 May 1989, *L.D.Ploper & G.Würschmidt s.n.* (BPI) [II]; Dept. Trancas, Rt. 9, km 1364, 26 Oct 1995, *J.R.Hernández 95-052* (BPI) [II]; San Javier, Parque Sierras de San Javier, La Cascada., 29 Mar 1996, *J.R.Hernández 96-014* (BPI 841122) [II-III].

ASCLEPIADACEAE

Puccinia sp.

on *Morrenia variegata* (Griseb.) T. Mey.; **Tucumán:** Alta Gracia, 19 Nov 1997, *J.R.Hernández 97-092* (BPI 841213) [0].

ASTERACEAE

Aecidium ampliatum H.S. Jacks. & Holw.

on *Eupatorium lasiophthalmum* Griseb.; **Catamarca:** near Balcozna, 28 Nov 1997, *J.R.Hernández 97-113* (BPI 841226) [0-I]. **Tucumán:** J.B. Alberdi, road to Escaba, bank of creek, 28 Nov 1997, *J.R.Hernández 97-103* (BPI 841221) [0-I].

Aecidium niederleinii Henn.[C,I,S,T]

on *Conyza* sp.; **Catamarca:** Dept. Ambatos, El Rodeo, 14 Nov 1999, *J.R.Hernández 99-007* (BPI 841276) [0-I]. **Salta:** Dept. Güemes, La Calderilla, 7 Dec 1997, *J.R.Hernández 97-167* (BPI) [I]. **Tucumán:** Alta Gracia, 19 Nov 1997, *J.R.Hernández 97-0932* (BPI 841215) [0-I]; Alta Gracia, 19 Nov 1997, *J.R.Hernández 97-087* (BPI) [0-I]; El Siambón, river next to monastery, 3 Nov 1997, *J.R.Hernández 97-145* (BPI 841243) [0-I].

Aecidium sp.

on *Senecio cremeiflorus* Mattf.; **Catamarca:** Rio Las Juntas, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-051* (BPI 841192) [I].

Cionothrix praelonga (G. Winter) Arthur[A]
on *Eupatorium* sp.[AR]; **Salta:** Dept. Santa Victoria, Los Toldos, El Nogalal, 29 Jun 1996, *J.R.Hernández 96-040* (BPI 841135) [III] **Tucumán:** San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-033* (LIL 54734, BPI) [III]; San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-035* (LIL 54735, BPI) [III].

Coleosporium tussilaginis (Pers.) Lév.
on *Senecio bravensis* Cabrera[S]; **Buenos Aires:** Partido de Gral. Pueyrredon, 2 Nov 1944, *A.L. Cabrera s.n.* [II].
on *Senecio cremeiflorus* Mattf.[S]; **Catamarca:** Dept. Ambatos, El Rodeo, 14 Nov 1999, *J.R.Hernández 99-004* (BPI 841273) [II]; N of Catamarca, Hwy. 38, 24 Sep 1997, *J.F.Hennen & J.R.Hernández 97-055* (BPI 841194) [II].
on *Senecio deferens* Griseb.; **Tucumán:** Sierras de San Javier, 17 Nov 1949, *Singer & Digilio s.n.* [II].
on *Senecio otopterus* Griseb.[S]; **Catamarca:** El Rodeo, 29 Nov 1997, *J.R.Hernández 97-126* (BPI 841231) [II].
on *Senecio rudbeckiifolius* Meyen & Walp.; **Tucumán:** Tafí del Valle, 6 Apr 1995, *J.R.Hernández 95-077* (BPI) [II]; Tafí del Valle, 6 Apr 1993, *J.F.Hennen & J.R.Hernández 93-120* (LIL 54736, BPI) [II].
on *Senecio* sp.; **Salta:** road to Parque del Rey, 6 Dec 1997, *J.R.Hernández 97-158* (BPI 841254) [II].

Coleosporium vernoniae Berk. & M.A. Curtis[A]
on *Elephantopus mollis* Kunth[AR]; **Tucumán:** San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R Hernández 93-029* (LIL 54737, BPI) [II]. San Miguel de Tucumán, 20 Jun 1994, *J.R.Hernández 94-168* (BPI 841075) [II].

Puccinia baccharidis Dietel & Holw.[C,S]
on *Baccharis lilloi* Heering[AR]; **Salta:** Cafayate, 9 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-111* (LIL 54754, BPI 841046) [I II III].
on *Baccharis salicifolia* (Ruiz & Pav.) Pers.; **Catamarca:** Balcozna, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-023* (BPI) [I III]; N of Catamarca, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-019* (BPI 841173) [II]; road to El Rodeo, camping area, 29 Nov 1997, *J.R.Hernández 97-120* (BPI 841228) [II-III]; W side of Catamarca, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-028* (BPI 841178) [I II].

Puccinia calcitrapae DC. var. **centaureae** (DC.) Cummins[A]
on *Carthamus tinctorius* L.[A]; **Salta:** Dept. Tartagal, General Ballivián, 25 Sep 1997, *A.C.Ramallo s.n.* (BPI 841201) [II-III].

Puccinia cnici-oleracei Pers.[A]
on *Vernonia remotiflora* Rich.[S]; **Tucumán:** Dept. Trancas, Rio de la Cuesta, elev. 1700 m, 19 Apr 1926, *S.Venturi 4138* [III].
on *Vernonia saltensis* Hieron.[S]; **Salta:** Metán, 1 Jun 1933, *A.L.Cabrera 3024* [III].

Puccinia colossea Speg.[T]
on *Baccharis latifolia* Lem.[S]; **Tucumán:** Tafí del Valle, 6 May 1995, *J.R.Hernández 95-078* (BPI 841106) [III]; Tafí del Valle, 6 Apr 1993, *J.F.Hennen & J.R.Hernández 93-123* (LIL 54738, BPI 841019) [III].

Puccinia conoclinii Seym. in Burrill[S]
on *Eupatorium macrocephalum* Less.[AR]; **Tucumán:** 9 km NW of Concepción de la Sierra, 11 Mar 1969, *A. Krapovickas et al. s.n.* [II]; Dept. Burruyacú, Cerro del Campo, elev. 1500 m, 29 Mar 1930, *S.Venturi s.n.* [II].
on *Eupatorium* sp.; **Salta:** Dept. Rosario de la Frontera, Horcones, 6 Dec 1997, *J.R.Hernández 97-154* (BPI 841251) [II]. **Tucumán:** Cevil Pozo, 12-15 km E of San Miguel de Tucumán, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-055* (LIL 54761, BPI 841003) [II].

Puccinia enceliae Dietel & Holw. var. **aemulans** (Syd. & P. Syd.) Parmelee[S]
on *Simsia dombeyana* DC[S]; **Salta:** Cafayate, 9 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-112* (LIL 54740, BPI 841047) [II-III].

Puccinia eupatorii Dietel[S,T]
on *Eupatorium* sp.; **Salta:** Cafayate, 8 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R. Hernández 94-101* (LIL 54742, BPI 841042) [II-III]. **Tucumán:** Dept. Trancas, Vipos, 30 Mar 1995, *J.R.Hernández 95-048*

(BPI 841089) [II-III]; San Pedro de Colalao, 1 Apr 1994, *J.F.Hennen & M.M.Hennen 94-053* (LIL 54741, BPI) [III].

Puccinia exornata Arthur[A]

on *Baccharis* sp. (A)[AR]; **Salta:** Quebrada de San Lorenzo, 6 Dec 1997, *J.R.Hernández 97-163* (BPI 841259) [I-II-III].

on *Baccharis* sp. (B)[AR]; **Catamarca:** naer Balcozna, 28 Nov 1997, *J.R.Hernández 97-112* (BPI 841225) [II].

Puccinia helianthi Schwein.[T]

on *Helianthus annuus* L.; **Tucumán:** Dept. Capital, 17 Dec 1995, *J.R.Hernández 95-095* (BPI) [II]; Horco Molle, Parque Sierras de San Javier, 29 Mar 1996, *J.R.Hernández 96-024* (BPI 841129) [II-III]; Monte Redondo, 24 Apr 1996, *J.R.Hernández 96-081* (BPI 841152) [II-III].

Puccinia hieracii (Röhl.) H. Mart.

on *Taraxacum officinale* Weber; **Catamarca:** Dept. Ambatos, El Rodeo, 14 Nov 1999, *J.R.Hernández 99-003* (BPI 841272) [II].

Puccinia investita Schwein.[S]

on *Achyrocline* sp.; **Salta:** Dept. Santa Victoria, La Misión, 30 Jun 1996, *J.R.Hernández 96-052* (BPI 841140) [II].

Puccinia lilloana J.C. Lindq.[T]

on *Baccharis lilloi* Heering; **Tucumán:** Tafí, 16 Apr 1904, leg. ? [III].

Puccinia lorentzii Henn.[J,T]

on *Vernonia scorpioides* (Lam.) Pers.; **Jujuy:** Quinta prop. Laguna de la Brea, 31 May 1901, *R.E.Frias s.n.* [II]. **Tucumán:** Horco Molle, 17 Sep 1997, *J.R.Hernández 97-075* (BPI 841205) [II].

Puccinia noccae Arthur[T]

on *Lagascea mollis* Cav.; **Tucumán:** Cruz Alta, San Agustín, 29 Mar 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-039* (BPI) [II-III]; Dept. Cruz Alta, San Agustín, Monte Redondo, 29 Mar 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-025* (LIL 54743, BPI) [II-III]; San Pedro de Colalao, 2 Apr 1994, *J.F.Hennen & M.M.Hennen 94-070* (LIL 54744, BPI 841032) [II-III].

Puccinia ocellifera Cummins[A]

on *Pluchea* sp.[AR]; **Tucumán:** J.B. Alberdi, road to Escaba, 28 Nov 1997, *J.R.Hernández 97-097* (BPI 841218) [II].

Puccinia petrakii J.C. Lindq.[S]

on *Baccharis tucumanensis* Hook. & Arn.; **Salta:** Dept. Santa Victoria, Los Toldos, El Nogalal, 29 Jun 1996, *J.R.Hernández 96-048* (BPI 841137) [I-III].

Puccinia proluviosa H.S. Jacks. & Holw.[A]

on *Senecio peregrinus* Griseb.[S]; **Catamarca:** E of La Viña, 24 Sep 1997, *J.F.Hennen & J.R.Hernández 97-057* (BPI 841196) [II]; W of Catamarca, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-045* (BPI 841189) [II]. **Tucumán:** 15 Sep 1949, *R.Singer & Digilio s.n.* [II-III]; Dept. Trancas, 27 Oct 1995, *J.R.Hernández 95-059* (BPI 841094) [II]; J.B. Alberdi, S of Escaba Dike, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-010* (BPI 841168) [II]; San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-162* (LIL 54746, BPI) [II]; San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-028* (LIL 54745, BPI) [II-III].

Puccinia rata H.S. Jacks. & Holw.[A]

on *Vernonia saltensis* Hieron.[S]; **Salta:** Capital, Cerro San Bernardo, 27 May 1933, *A.L.Cabrera 3021* [II-III]. **Tucumán:** Dept. Trancas, Vipos, elev. 780 m, 19 Mar 1928, *Screiter 47843* [I-II-III]; San Pedro de Colalao, 1 Apr 1994, *J.F.Hennen & M.M.Hennen 94-058* (LIL 54747, BPI 841028) [II-III].

Puccinia schileana Speg. var. **partheniicola** (H.S. Jacks. & Holw.) J.C. Lindq.

on *Parthenium hysterophorus* L.; **Tucumán:** Cruz Alta, San Agustín, 30 Mar 1994, *J.F. Hennen, M.M.Hennen & J.R. Hernández 94-031* (LIL 54748, BPI 841022) [II-III]; Dept. Trancas, Vipos, 28 Mar 1996, *J.R.Hernández 96-012* (BPI 841121) [II]; San Pedro de Colalao, 2 Apr 1994, *J.F.Hennen & M.M.Hennen 94-066* (LIL 54749, BPI) [II].

Puccinia schileana Speg. var. **schileana**

on *Verbesina lilloi* S.F. Blake; **Jujuy:** Dept. Tumbaya, volcano, on slope to abra de Tiraxi, 31 Dec 1952, *H. Sleumer s.n.* [0-I-II].

Puccinia singeri J.C. Lindq.

on *Verbesina* sp.; **Tucumán:** Sierras de San Javier, 15 Nov 1950, *R.Singer s.n.* [II-III].

on *Verbesina suncho* (Griseb.) S.F. Blake; **Tucumán:** J.B. Alberdi, S of Escaba Dike, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-011* (BPI 841169) [II].

Puccinia sp.

on *Baccharis* sp.; **Salta:** Dept. Santa Victoria, La Misión, 30 Jun 1996, *J.R.Hernández 96-062B* (BPI) [I-III]. **Tucumán:** Tafí del Valle, 6 Apr 1993, *J.F.Hennen & J.R.Hernández 93-122* (LIL 54757, BPI 841018) [I-II-III].

Puccinia sp. A[N]

on *Vernonia fulta* Griseb.[N]; **Tucumán:** Dept. Trancas, Rt. 9, km 1364, 26 Oct 1995, *J.R.Hernández 95-055* (BPI 841093) [III]; San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-141* (LIL 54758, BPI 841065) [III].

on *Vernonia* sp.; **Tucumán:** Horco Molle, Parque Sierras de San Javier, 6 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R. Hernández 94-091A* (BPI) [I-III].

Puccinia sp. B[N]

on *Vernonia squamosa* Gardner; **Catamarca:** Balcozna, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-022* (BPI 841175) [II-III]. **Salta:** Orán, Jul-Aug 1873, *P.G.Lorentz & G.Hieronymus s.n.* [II-III]. **Tucumán:** Dept. Capital, elev. 480 m, 15 Aug 1909, *Lillo 3792* [II-III].

Puccinia sp. C[N]

on *Vernonia* sp.; **Salta:** road to Parque del Rey, 6 Dec 1997, *J.R.Hernández 97-161* (BPI 841257) [II-III]. **Tucumán:** El Siambón, river next to monastery, 3 Nov 1997, *J.R.Hernández 97-147* (BPI 841245) [II]; J.B. Alberdi, Escaba Dike, 28 Nov 1997, *J.R.Hernández 97-106* (BPI 841223) [III]; Yerba Buena, 29 Mar 1993, *J.R.Hernández 93-047* (LIL 54755, BPI) [II].

Puccinia sp.(A)

on *undtn.*, **Salta:** Dept. Santa Victoria, La Misión, 30 Jun 1996, *J.R.Hernández 96-056* (BPI 841142) [III].

Puccinia sp.(B)

on *undtn.*; **Tucumán:** NW of San Miguel de Tucumán, 31 Mar 1993, *J.F.Hennen & J.R.Hernández 93-088* (LIL 54759, BPI 841009) [II-III].

Puccinia spegazzinii De Toni[N]

on *Mikania micrantha* Kunth[N]; **Tucumán:** Horco Molle, 15 May 1995, *J.R.Hernández 95-079* (BPI) [III]; Horco Molle, Parque Sierras de San Javier, 6 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-088* (LIL 54752, BPI) [III]; San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-160* (LIL 54753, BPI) [III]

on *Mikania periplocifolia* Hook. & Arn.; **Salta:** Los Vaqueros, 7 Dec 1997, *J.R.Hernández 97-165* (BPI 841261) [III]; Metán, 2 Apr 1993, *J.F.Hennen & L.D.Ploper 93-113* (LIL 54751, BPI) [III]. **Tucumán:** 19.5 km W of San Miguel de Tucumán, mtn, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-010* (LIL 54750, BPI) [III]; Dept. Trancas, Vipos, 28 Mar 1996, *J.R.Hernández 96-009* (BPI) [III]; J.B. Alberdi, road to Escaba, 28 Nov 1997, *J.R.Hernández 97-098* (BPI) [III].

on *Mikania* sp.; **Tucumán:** 15 Jan 1895, *C. Spegazzini s.n.* [III]; Dept. Capital, 15 Jun 1992, *J.R.Hernández 92-005* (BPI) [III].

Puccinia tanaceti DC. var **tanaceti**[A]

on *Chrysanthemum* sp.[AR]; **Tucumán:** San Miguel de Tucumán, 15 Dec 1994, *J.R.Hernández 94-170* (BPI 841076) [II].

Puccinia unicolor Arthur[A]

on *Baccharis* sp.[AR]; **Tucumán:** Alta Gracia, 19 Nov 1997, *J.R.Hernández 97-0931* (BPI 841214) [II].

Uredo sp

on *Baccharis* sp.; **Tucumán:** Tafí del Valle, 6 Apr 1993, *J.F.Hennen & J.R.Hernández 93-118* (LIL 54756, BPI 841017) [II].

on *Eupatorium* sp.; **Tucumán:** Valle de Las Salas, bank of Río Las Salas, 3 Nov 1997, *J.R.Hernández 97-151* (BPI 841248) [II].

Uromyces aspiliae H.S. Jacks. & Holw.[A]

on *Aspilia* sp.[AR]; **Tucumán:** Horco Molle, 14 Nov 1997, *J.R.Hernández 97-130* (BPI 841234) [0-I-II-III].

on *Wedelia saltensis* Cabrera[N]; **Tucumán:** Horco Molle, 21 Dec 1992, *J.R.Hernández 92 004* (BPI 840991) [II-III].

Uromyces bidenticola Arthur

on *Bidens pilosa* L.; **Tucumán:** Horco Molle, 17 Sep 1997, *J.R.Hernández 97-078* (BPI 841207) [II]; Horco Molle, Parque Sierras de San Javier, 29 Mar 1996, *J.R.Hernández 96-022* (BPI 841128) [II]; Horco Molle,

Parque Sierras de San Javier, 6 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-087* (LIL 54762, BPI) [II-III]; San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-151* (LIL 54763, BPI) [II].

on *Bidens* sp.; **Tucumán:** 19.5 km W of San Miguel de Tucumán, mtn, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-014* (LIL 54764, BPI) [II-III]; J.B. Alberdi, road to Escaba, 28 Nov 1997, *J.R. Hernández 97-096* (BPI 841217) [II].

Uromyces megalospermus Speg.

on *Tessaria absinthioides* (Hook. & Arn.) DC.; **Catamarca:** N of Catamarca, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-017* (BPI 841171) [II-III]; N of Catamarca, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-018* (BPI 841172) [II-III]; road to El Rodeo, camping area, 29 Nov 1997, *J.R. Hernández 97-115* (BPI 841227) [II]; W side of Catamarca, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-024* (BPI 841176) [II]; W side of Catamarca, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-027* (BPI) [II].

Uromyces polymniae Dietel & Holw.

on *Polymnia connata* (Spreng.) S.F. Blake; **Tucumán:** NW of San Miguel de Tucumán, 31 Mar 1993, *J.F.Hennen & J.R.Hernández 93-090* (LIL 54765, BPI 841010) [II-III].

BERBERIDACEAE

Edythea quitensis (Lagerh.) H.S. Jacks. & Holw.[A]

on *Berberis* sp.; **Tucumán:** Tafí del Valle, 6 Apr 1993, *J.F.Hennen & J.R.Hernández 93-116* (LIL 54711, BPI 841016) [II-III].

BETULACEAE

Melampsoridium hiratsukanum S. Ito ex Hirats. f.[A]

on *Alnus acuminata* Kunth[A]; **Salta:** Dept. Santa Victoria, La Misión, 30 Jun 1996, *J.R.Hernández 96-058* (BPI 841143) [II]; Dept. Santa Victoria, Los Toldos, 28 Jun 1996, *J.R.Hernández 96-033* (BPI 841132) [II]. **Tucumán:** road to Villa Nougués, 5 May 1995, *J.R.Hernández 95-035* (BPI 841082) [II]; San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-039* (LIL 54712, BPI) [II].

BIGNONIACEAE

Prospodium appendiculatum (G. Winter) Arthur

on *Tecoma stans* (L.) Juss. ex Kunth in H.B.K.; **Catamarca:** E of La Viña, 24 Sep 1997, *J.F.Hennen & J.R.Hernández 97-060* (BPI) [I]. **Jujuy:** Caimancito, 2 Apr 1993, *J.F.Hennen & L.D.Ploper 93-110* (LIL 54714, BPI) [I-II]; Parque Nacional Calilegua, 8 Dec 1997, *J.R.Hernández 97-180* (BPI 841268) [I]; Santa Clara, 12 Apr 1994, *J.F.Hennen & L.D.Ploper 94-131* (LIL 54716, BPI) [II]. **Salta:** Dept. Santa Victoria, La Misión, 30 Jun 1996, *J.R.Hernández 96-055* (BPI 841141) [II-III]; General San Martín, 7 Dec 1997, *J.R.Hernández 97-172* (BPI 841262) [I]. **Tucumán:** Horco Molle, 15 Nov 1995, *J.R.Hernández 95-090* (BPI) [I]; Horco Molle, 14 Nov 1997, *J.R. Hernández 97-132* (BPI) [I]; J.B. Alberdi, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-002* (BPI 841161) [I]; J.B. Alberdi, road to Escaba, 28 Nov 1997, *J.R.Hernández 97-099* (BPI 841219) [I]; road to Villa Nougués, 5 May 1995, *J.R.Hernández 95-036* (BPI 841083) [II-III]; San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-027* (LIL 54713, BPI) [I-II]; San Pedro de Colalao, 1 Apr 1994, *J.F.Hennen & M.M.Hennen 94-061* (LIL 54715, BPI 841030) [II-III].

Prospodium elegans (J. Schröt) Cummins[S]

on *Tecoma garrocha* Hieron.; **Salta:** Cafayate, 9 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-115* (LIL 54717, BPI 841048) [III].

Prospodium perornatum Syd.[J,S]

on *Tabebuia avellanedae* Lorentz ex Griseb.; **Jujuy:** Parque Nacional Calilegua, 8 Dec 1997, *J.R.Hernández 97-181* (BPI 841269) [0-I]. **Salta:** Dept. Santa Victoria, La Misión, 30 Jun 1996, *J.R.Hernández 96-057* (BPI) [III]. **Tucumán:** Cevil Pozo, 12-15 km E of San Miguel de Tucumán, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-056* (LIL 54739, BPI) [II-III]; Dept. Capital, 1 Nov 1995, *J.R.Hernández 95-062* (BPI 841095) [0-I]; Dept. Capital, 1 Nov 1995, *J.R.Hernández 95-061* (BPI) [0-I]; Dept. Capital, 4 Apr 1994, *J.F.Hennen & J.R.Hernández 94-080* (LIL 54718, BPI) [II-III]; Dept. Capital, Quinta Agronómica, 31 Oct 1997, *J.R.Hernández 97-070* (BPI) [0-

I]; Dept. Monteros, 29 Oct 1996, *J.R.Hernández 96-077* (BPI) [0-I]; El Corte, 15 Feb 1995, *J.R.Hernández 95-067* (BPI 841099) [0-I]; El Manantial, 27 Sep 1997, *J.F.Hennen & J.R.Hernández 97-064* (BPI 841198) [0]; Horco Molle, Parque Sierras de San Javier, 6 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-092* (LIL 54719, BPI) [II-III]; San Javier, 21 Mar 1995, *J.R.Hernández 95-072* (BPI 841103) [II-III]; Yerba Buena, 5 Oct 1997, *J.R.Hernández 97-074* (BPI) [0].

Prospodium pithecoctenii (Pazschke) Cummins[A]
on *Pithecoctenium* sp.; **Salta:** Las Lajitas, 12 Apr 1994, *J.F.Hennen & L.D.Ploper 94 130* (LIL 54722, BPI 841057) [II-III]. **Tucumán:** Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-061* (LIL 54721, BPI) [II-III]; San Pedro de Colalao, 1 Apr 1994, *J.F.Hennen & M.M.Hennen 94-055* (LIL 54720, BPI 841026) [II-III].

Prospodium singeri Petr.[A]
on *Clytostoma callistegioides* (Cham.) Bureau ex Griseb.[AR]; **Tucumán:** San Miguel, Jardín Botánico Inst. Miguel Lillo, 30 Aug 1951, *R.Singer* s.n. [II-III].

Uropyxis rickiana Magnus[A]
on *Macfadyena unguis-cati* (L.) A.H. Gentry; **Salta:** Dept. Rosario de la Frontera, Horcones, 6 Dec 1997, *J.R.Hernández 97-153* (BPI 841250) [II-III]; Posta de Yatasto, 6 Dec 1997, *J.R.Hernández 97-155* (BPI) [II]. **Tucumán:** 19.5 km W of San Miguel de Tucumán, mtn, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-013* (LIL 54723, BPI) [II-III]; Horco Molle, 15 Mar 1992, *J.R.Hernández 92-002* (BPI) [II-III].

BORAGINACEAE

Aecidium tournefortiae Henn.[A]
on *Tournefortia paniculata* Cham.[A]; **Tucumán:** Raco, 3 Nov 1997, *J.R.Hernández 97-141* (BPI 841240) [0-I].

Puccinia cordiae Arthur[A]
on *Cordia* sp.; **Jujuy:** Parque Nacional Calilegua, 8 Dec 1997, *J.R.Hernández 97-178* (BPI 841266) [I]. **Salta:** Dept. Güemes, 7 Dec 1997, *J.R.Hernández 97-171* (BPI) [III].

Uromyces dolichosporus Dietel & Holw.[A]
on *Tournefortia rubicunda* DC.[A]; **Tucumán:** San Pedro de Colalao, 2 Apr 1994, *J.F.Hennen & M.M.Hennen 94-072* (LIL 54724, BPI 841033) [II-III].

CACTACEAE

Uromyces pereskiae Dietel[I]
on *Pereskia aculeata* Mill.; **Jujuy:** Santa Clara, 12 Apr 1994, *J.F.Hennen & L.D.Ploper 94-125* (LIL 54725, BPI 841055) [III].

CANNACEAE

Puccinia thaliae Dietel[I]
on *Canna compacta* Roscoe[A]; **Tucumán:** Yerba Bueba, 15 Nov 1995, *J.R.Hernández 95-089* (BPI 841112) [II-III].
on *Canna* sp.; **Tucumán:** Dept. Capital, 12 Aug 1994, *J.R.Hernández 94-153* (LIL 54726, BPI 841070) [II-III].

CARYOPHYLLACEAE

Uromyces dianthi (Pers.) Niessl
on *Dianthus* sp.; **Tucumán:** Lules, 17 Aug 1995, *J.R.Hernández 95-086* (BPI) [II].

CHENOPODIACEAE

Puccinia subnitens Dietel[A]
on *Suaeda divaricata* Moq.; **Salta:** Cafayate, 9 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-110* (LIL 54727, BPI 841045) [I]

COMMELINACEAE

Phakopsora tecta H.S. Jacks. & Holw.
on *Commelina* sp.; **Tucumán:** Dept. Trancas, Vipos, 28 Mar 1996, *J.R.Hernández 96-006* (BPI 841118) [II]; Horco Molle, Parque Sierras de San Javier, 6 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-095* (LIL 54728, BPI) [II]; San Javier, 23 Jun 1995, *J.R.Hernández 95-084* (BPI 841109) [II].

Puccinia commelinae Holw.[A]
on *Tradescantia* sp.[AR]; **Tucumán:** Horco Molle, 11 Nov 1990, *J.R.Hernández 90-001* (BPI) [II].
on *Tripogandra elongata* (G. Mey.) Woodson[A]; **Salta:** Dept. Santa Victoria, Los Toldos, 28 Jun 1996, *J.R.Hernández 96-032* (BPI) [II]. **Tucumán:** Horco Molle, Parque Sierras de San Javier, 6 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-082* (LIL 54729, BPI) [II].
on *Tripogandra* sp.[A]; **Tucumán:** 19.5 km W of San Miguel de Tucumán, mtn, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R. Hernández 93-009* (LIL 54730, BPI) [II];

Horco Molle, 17 Sep 1997, *J.R.Hernández 97-079* (BPI) [II]; Horco Molle, 14 Nov 1997, *J.R.Hernández 97-134* (BPI 841237) [II]; Yerba Buena, 29 Mar 1993, *J.R.Hernández 93-046* (LIL 54731, BPI 841000) [II-III].

Uromyces commelinae Cooke

on *Commelina* sp.; **Tucumán:** Dept. Capital, 17 Dec 1995, *J.R.Hernández 95-093* (BPI 841114) [II]; San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-155* (LIL 54732, BPI 841071) [II-III].

CONVOLVULACEAE

Puccinia crassipes Berk. & Curt. var. **crassipes**[I]

on *Ipomoea cairica* (L.) Sweet; **Tucumán:** Dept. Capital, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-042* (LIL 54767, BPI) [II]; J.B. Alberdi, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-001* (BPI 841160) [II]; J.B. Alberdi, road to Escaba, 28 Nov 1997, *J.R.Hernández 97-095* (BPI) [II]; San Miguel de Tucumán, 10 Jun 1992, *J.R.Hernández 92-001* (BPI) [II-III].

on *Ipomoea hieronymi* (Kuntze) O'Donell; **Jujuy:** Santa Clara, 12 Apr 1994, *J.F. Hennen & L.D.Ploper s.n.* (LIL 54768, BPI 841058) [II-III].

on *Ipomoea* sp.; **Jujuy:** Pampa Blanca, 1 Apr 1993, *J.F.Hennen & L.D.Ploper 93-099* (LIL 54769, BPI 841013) [II]. **Tucumán:** Amberes, 5 May 1989, *L.D.Ploper & G.Würschmidt s.n.* (BPI) [II-III].

Puccinia dichondrae Mont.

on *Dichondra sericea* Sw.[A]; **Buenos Aires:** La Plata, 29 Sep 1997, *J.F.Hennen & J.R. Hernández 97-071* (BPI 841203) [III]. **Catamarca:** Dept. Ambatos, El Rodeo, 14 Nov 1999, *J.R.Hernández 99-005* (BPI 841274) [III]. **Tucumán:** El Siambón, river next to monastery, 3 Nov 1997, *J.R. Hernández 97-149* (BPI 841246) [III].

on *Dichondra* sp.; **Tucumán:** San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R. Hernández 94-158* (LIL 54766, BPI) [III].

CUCURBITACEAE

Uromyces novissimus Speg.

on *Cayaponia citrullifolia* (Griseb.) Cogn.; **Tucumán:** Dept. Capital, 12 Aug 1994, *J.R.Hernández 94-139* (LIL 54770, BPI) [III]; Las Salas, 5 May 1995, *J.R.Hernández 95-021* (BPI 841080) [III].

on *Cucurbitella cucumifolia* (Griseb.) Cogn.[A]; **Tucumán:** San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R. Hernández 94-148* (LIL 54771, BPI 841069) [III].

on *undtn.*; **Tucumán:** Horco Molle, Parque Sierras de San Javier, 6 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-094* (LIL 54772, BPI 841037) [II-III].

CYPERACEAE

Puccinia cyperi Arthur

on *Cyperus* sp.; **Tucumán:** San Pedro de Colalao, 2 Apr 1994, *J.F.Hennen & M.M.Hennen 94-075* (LIL 54773, BPI 841035) [II-III].

DRYOPTERIDACEAE

Desmella anemiae Syd. & P. Syd.[A]

on *Athyrium lilloi* (Hicken) Alston[S]; **Tucumán:** Las Lenguas, 22 Oct 1950, *R.Singer s.n.* [II]; Las Lenguas, 22 Oct 1950, *R.Singer s.n.* [II].

ERYTHROXYLACEAE

Phakopsora coca Buriticá & J.F. Hennen

on *Erythroxylum coca* Lam.; **Jujuy:** 2 Apr 1993, *J.F.Hennen & L.D.Ploper 93-115* (LIL 54774, BPI) [II]. **Salta:** Cafayate, 10 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R. Hernández 94-135A* (LIL 54775, BPI 841061) [II].

EUPHORBIACEAE

Uromyces cisneroanus Speg.[C I]

on *Sapium haematospermum* Mül.Arg.; **Catamarca:** W side of Catamarca, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-033* (BPI 841182) [II-III]. **Tucumán:** Dept. Capital, 14 May 1995, *J.R.Hernández 95-051* (BPI 841092) [II-III]; El Manantial, 5 Mar 1996, *J.R.Hernández 96-076* (BPI 841149) [II-III]; Los Gutierrez, 15 Aug 1994, *J.R.Hernández 94-171* (BPI) [III]; San Pedro de Colalao, 1 Apr 1994, *J.F.Hennen & M.M.Hennen 94-062* (LIL 54779, BPI) [II-III]; San Pedro de Colalao, 31 Mar 1994, *J.F.Hennen & M.M.Hennen 94-047* (LIL 54778, BPI) [III].

Uromyces euphorbiae Cooke & Peck

on *Euphorbia hirta* L.; **Tucumán:** Dept. Cruz Alta, San Agustín, Monte Redondo, 29

Mar 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-028* (LIL 54776, BPI) [II-III]; San Pedro de Colalao, 31 Mar 1994, *J.F.Hennen & M.M.Hennen 94-046* (LIL 54777, BPI 841024) [III].

FABACEAE

Phakopsora meibomiae (Arthur) Arthur[A]

on *Cologania ovalifolia* Kunth[S]; **Tucumán:** 22 km W of San Miguel de Tucumán, mtn, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R. Hernández 93-018* (LIL 54819, BPI 840995) [II].

Phragmopyxis deglubens (Berk. & M.A. Curtis) Dietel in Engl. & Prantl[A]

on *Coursetia brachyrhachis* Harms[S]; **Jujuy:** Pampa Blanca, 1 Apr 1993, *J.F. Hennen & L.D.Ploper 93-097* (LIL 54820, BPI 841012) [II-III]

Puccinia bergii Speg.[A]

on *Poiretia tetraphylla* (Prior.) Burkart[A]; **Corrientes:** Dept. Concepción, Rincón de Luna, Estancia Santillana, 26 Feb1957, *T.M.Pedersen 4483* [II].

Ravenelia argentinensis Speg.[C,S]

on *Acacia aroma* Gillies in Hook. & Arn.; **Catamarca:** N of Catamarca, Hwy. 38, 24 Sep 1997, *J.F.Hennen & J.R.Hernández 97-052* (BPI 841193) [I]. **Jujuy:** Parque Nacional Calilegua, 8 Dec1997, *J.R.Hernández 97-179* (BPI 841267) [I]. **Salta:** Metán, 2 Apr 1993, *J.F.Hennen & L.D.Ploper 93-103* (LIL 54823, BPI 841014) [I-II III]; road to Parque del Rey, 6 Dec 1997, *J.R.Hernández 97-160* (BPI 841256) [I]. **Tucumán:** Cevil Pozo, 30 Mar 1993, *J.F.Hennen & J.R Hernández 93-051* (LIL 54824, BPI) [II]; Cruz Alta, San Agustín, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93 059* (LIL 54825, BPI) [II-III]; Cruz Alta, San Agustín, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93 060A* (LIL54845, BPI) [III]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-076* (LIL 54821, BPI) [I-II]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-072* (LIL 54848, BPI) [I-II]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-078* (LIL 54822, BPI) [I-II-III]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-065* (LIL 54826, BPI) [II-III]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-069* (LIL 54847, BPI) [I-II-III]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-074* (LIL 54827, BPI) [II-III]; Raco, 3 Nov 1997, *J.R.Hernández 97-143* (BPI) [II]; Raco, 3 Nov 1997, *J.R.Hernández 97-142* (BPI 841241) [I]; San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-032* (LIL 54844, BPI) [I-II-III]

Ravenelia cebil Speg.

on *Anadenanthera* sp.[S]; **Jujuy:** Caimancito, 2 Apr 1993, *J.F.Hennen & L.D.Ploper 93-111* (LIL 54831, BPI) [II III]; Pampa Blanca, 1 Apr 1993, *J.F.Hennen & L.D.Ploper 93-100* (LIL 54829, BPI) [II III]; San Pedro, 2 Apr 1993, *J.F.Hennen & L.D.Ploper 93 107* (LIL 54830, BPI) [II-III]. **Tucumán:** San Pedro de Colalao, 1 Apr 1994, *J.F.Hennen & M.M.Hennen 94-059* (LIL 54828, BPI 841029) [II-III].

Ravenelia cohniana Henn.[A]

on *Legum. undetn.*; **Jujuy:** Chalicán, 2 Apr 1993, *J.F.Hennen & L.D.Ploper 93-105* (LIL 54832, BPI 841015) [II-III].

Ravenelia echinata Lagerh. & Dietel var. **ectypa** (Arthur & Holw.) Cummins[A]

on *Calliandra formosa* (Kunth) Benth.[S]; **Salta:** Pichanal, 2 Apr 1993, *J.F.Hennen & L.D.Ploper 93-102* (LIL 54835, BPI) [II-III]. **Tucumán:** San Pedro de Colalao, 1 Apr 1994, *J.F.Hennen & M.M.Hennen 94-054* (LIL 54836, BPI) [II-III]; San Pedro de Colalao, 2 Apr 1994, *J.F.Hennen & M.M. Hennen 94-073* (LIL 54837, BPI 841034) [II-III].

Ravenelia hieronymi Speg.[C,T]

on *Acacia caven* (Molina) Molina; **Catamarca:** Rio Las Juntas, camping area, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-038* (BPI) [An]; W of Catamarca, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-044* (BPI 841188) [III]. **Tucumán:** J.B. Alberdi, S of Escaba Dike, 28 Nov 1997, *J.R.Hernández 97-108* (BPI 841224) [An-III]; SW of J.B. Alberdi, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-007* (BPI 841166) [An-III]; SW of J.B. Alberdi, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-006* (BPI 841165) [An III].

Ravenelia lindquistii J.F. Hennen & Cummins[T]

on *Acacia praecox* Griseb.; **Catamarca:** bank

of Rio Las Juntas, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-041* (BPI 841187) [II-III]; Rio Las Juntas, camping area, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-039* (BPI 841185) [II-III]. **Salta:** Pichanal, 2 Apr 1993, *J.F.Hennen & L.D.Ploper 93-109* (LIL 54834, BPI) [II-III]; Pichanal, 2 Apr 1993, *J.F.Hennen & L.D.Ploper 93-108* (LIL 54850, BPI) [II]. **Tucumán:** San Pedro de Colalao, 2 Apr 1994, *J.F.Hennen & M.M. Hennen 94-067* (LIL 54833, BPI) [II-III].

Ravenelia lonchocarpicola var. **lonchocarpicola** Speg.[J]

on *Lonchocarpus lilloi* (Hassl.) Burkart[>]; **Jujuy:** Ledesma, between Valle Grande and Rio Agua Negra, 8 Apr 1971, *Legname & Cuezzo 7970c* [0-III]; Ledesma, from Rio Agua Negra to Alba de Cañas, 29 May 1977, *Legname & Cuezzo 8247c* [III].

Ravenelia macrocarpa Syd. & P. Syd.[A]

on *Senna birostris* var. *hookeriana* (Gillies ex Hook. & Arn.) H.S. Irwin & Barneby[A]; **Tucumán:** Dept. Trancas, Cuesta Grande, 22 Apr 1926, *S.Venturi s.n.* [III]; Dept. Trancas, Cuesta Grande, 22 Apr 1926, *S.Venturi s.n.* [III]; Tafí del Valle, 6 Apr 1993, *J.F.Hennen & J.R.Hernández 93-117* (LIL 54838, BPI) [II-III].

on *Senna hookeriana* Batke[A]; **Tucumán:** Tafí, 19 Mar 1944, *A.Courteig 516* [II-III].

on *Senna subulata* (Griseb.) H.S. Irwin & Barneby[>]; **Catamarca:** E of La Viña, 24 Sep 1997, *J.F.Hennen & J.R.Hernández 97-056* (BPI 841195) [II]. **Tucumán:** Dept. Tafí, 7 Feb 1924, *S.Venturi s.n.* [II-III]; San Javier. Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-156* (LIL 54839, BPI) [II]

Ravenelia mimosae-sensitivae Henn.

on *Mimosa debilis* Humb. & Bonpl. ex Willd. var. *debilis*[>]; **Salta:** Between Rosario de la Frontera and Horcones, 11 Apr 1994, *J.F.Hennen & L.D.Ploper 94-120* (LIL 54843, BPI 841052) [II-III]. **Tucumán:** Cruz Alta, San Agustín, 30 Mar 1994, *J.F. Hennen, M.M.Hennen & J.R.Hernández 94-035* (LIL 54842, BPI) [II-III]; Dept. Cruz Alta, San Agustín, Monte Redondo, 29 Mar 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-027* (LIL 54841, BPI) [II-III]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-073* (LIL 54840, BPI) [II-III].

Ravenelia papillosa Speg.[C]

on *Acacia visco* Lorentz ex Griseb.; **Catamarca:** Dept. Ambatos, El Rodeo, El Nogalal, 14 Nov 1999, *J.R.Hernández 99-009* (BPI 841277) [An]; Dept. Ambatos, El Rodeo, El Nogalal, 14 Nov 1999, *J.R.Hernández 99-001* (BPI 841270) [An]. **Tucumán:** Las Salas, 5 May 1995, *J.R.Hernández 95-019* (BPI) [II-III]; Dept. Trancas, Vipos, 28 Mar 1996, *J.R.Hernández 96-007* (BPI 841119) [II-III].

on *Parapiptadenia excelsa* (Griseb.) Burkart[>]; **Catamarca:** Dept. Ambatos, El Rodeo, El Nogalal, 23 Sep 1997, *J.F.Hennen & J.R. Hernández 97-049* (BPI 841191) [An-III].

Ravenelia platensis Speg.[C]

on *Erythrina crista-galli* L.; **Buenos Aires:** La Plata, 29 Sep 1997, *J.F.Hennen & J.R. Hernández 97-073* (BPI 841204) [0].

Ravenelia sp.

on *undtn.*; **Tucumán:** Cevil Pozo, 12-15 km E of San Miguel de Tucumán, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-052* (LIL 54849, BPI 841002) [II-III].

Ravenelia spegazziniana J.C. Lindq.[>T]

on *Acacia aroma* Gillies ex Hook. & Arn.; **Salta:** Metán, 2 Apr 1993, *J.F.Hennen & L.D.Ploper 93-103A* (LIL54823, BPI) [III]. **Tucumán:** Cruz Alta, San Agustín, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-059A* (LIL54825, BPI) [III]; Cruz Alta, San Agustín, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-060* (LIL 54845, BPI) [II-III]; Cruz Alta, San Agustín, 30 Mar 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-038* (LIL 54846, BPI) [III]; Dept. Trancas, Vipos, 30 Mar 1995, *J.R.Hernández 95-044* (BPI 841087) [III]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-076A* (LIL54821, BPI 841005) [II]; Monte Redondo, 31 Mar 1996, *J.R. Hernández 96-089* (BPI) [II-III].

Uromyces appendiculatus (Pers.) Unger

on *Phaseolus vulgaris* L.; **Salta:** Between Rosario de la Frontera and Horcones, 11 Apr 1994, *J.F.Hennen & L.D.Ploper 94-121* (LIL 54852, BPI) [II]; Cafayate, 9 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-107* (LIL 54851, BPI) [II-III]. **Tucumán:**

Dept. Trancas, 17 Mar 1995, *J.R. Hernández 95-070* (BPI 841102) [II]; Las Criollas, 21 Nov 1986, *L.D.Ploper & G.Würschmidt s.n.* (BPI) [II-III].

Uromyces castaneus P. Syd. & Syd.[A]

on *Desmodium purpureum* Hook. & Arn.[A]; **Salta:** Dept. Santa Victoria, Los Toldos, El Nogalal, 29 Jun 1996, *J.R.Hernández 96-041* (BPI 841136) [II-III].

Uromyces dietelianus Pazsche[A]

on *Bauhinia forficata* Link[A]; **Buenos Aires:** Castelar, 3 Mar 1996, *J.R.Hernández 96 064* (BPI 841145) [II-III]. **Tucumán:** El Corte, 15 Nov 1997, *J.R.Hernández 97-085* (BPI 841211) [II III].

Uromyces hedysari-paniculati (Schwein.) Farl. apud Ellis·

on *Desmodium* sp.; **Tucumán:** NW of San Miguel de Tucumán, 31 Mar 1993, *J.F. Hennen & J.R.Hernández 93-092* (LIL 54860, BPI) [I II III]; NW of San Miguel de Tucumán, 31 Mar 1993, *J.F.Hennen & J.R.Hernández 93-091* (LIL 54855, BPI 841011) [II-III]; San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-022* (LIL 54856, BPI) [I-II-III].

Uromyces orbicularis Dietel[A]

on *Desmodium purpureum* Hook. & Arn.[A]; **Tucumán:** San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D. Ploper & J.R.Hernández 93-034* (LIL 54853, BPI) [II-III]; San Miguel de Tucumán, 23 Jun 1995, *J.R.Hernández 95 082* (BPI 841108) [II-III].

on *Desmodium* sp.; **Tucumán:** NW of San Miguel de Tucumán, 31 Mar 1993, *J.F. Hennen & J.R.Hernández 93-091A* (LIL54855, BPI) [I-III]; San Pedro de Colalao, 31 Mar 1994, *J.F.Hennen & M.M. Hennen 94-048* (LIL 54857, BPI) [II-III].

on *Desmodium subsericeum* Malme[A]; **Tucumán:** San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94 159* (LIL 54854, BPI) [II-III].

Uromyces striatus Schröt.

on *Medicago sativa* L.; **Salta:** Cafayate, 9 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R. Hernández 94-108* (LIL 54859, BPI) [II] **Tucumán:** Dept. Trancas, Vipos, 28 Mar 1996, *J.R.Hernández 96-002* (BPI 841117) [II]

Uromyces trifolii-repentis Liro[1]

on *Trifolium repens* L.; **Tucumán:** Cruz Alta, 15 Mar 1996, *J.R.Hernández 96-092* (BPI 841158) [II-III]; NW of San Miguel de Tucumán, 31 Mar 1993, *J.F.Hennen & J.R. Hernández 93-093* (LIL 54858, BPI) [III].

Uromyces viciae-fabae (Pers.) Schröt.[1]

on *Vicia faba* L.; **Tucumán:** Tafí Viejo, 9 Nov 1997, *J.R.Hernández 97-065* (BPI 841199) [II III]

Ypsilospora sp.[A]

on *Inga edulis* Mart.[AR]; **Tucumán:** Dept. Capital, Quinta Agronómica, 28 Mar 1994, *J.F.Hennen & M.M.Hennen 94-024* (LIL 54817, BPI) [I]; Dept. Capital, Quinta Agronómica, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-049* (LIL 54816, BPI 841001) [I]; Dept. Capital, Quinta Agronómica, 6 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-096* (LIL 54818, BPI 841038) [II-III].

GERANIACEAE

Puccinia pelargonii-zonalis Doidge[A]

on *Pelargonium hortorum* L.H. Bailey[A], **Tucumán:** Dept. Capital, 29 Jul 1994, *J.R.Hernández 94-146* (LIL 54781, BPI) [II]; Dept. Capital, Quinta Agronómica, 28 Mar 1994, *J.F.Hennen & M.M.Hennen 94-023* (LIL 54780, BPI) [II]; Dept. Capital, Quinta Agronómica, 15 Apr 1995, *J.R. Hernández 95-075* (BPI) [II-III]; San Miguel de Tucumán, 15 Apr 1991, *J.R. Hernández 91-001* (BPI 840990) [II]; Tafi viejo, 15 Aug 1994, *I.Zarsoza s.n.* (LIL 54782, BPI) [II]; Yerba Buena, 19 Jul 1996, *J.R.Hernández 96-072* (BPI 841148) [II].

IRIDACEAE

Uromyces transversalis (Thüm.) G. Winter[A]

on *Gladiolus* sp.[A]; **San Luis:** Villa Mercedes, 22 Apr 1995, leg. ? (BPI 841104) [II-III]. **Tucumán:** Dept. Capital, 27 Jun 1996, *J.R.Hernández 96-028* (BPI 841131) [II]; Dept. Capital, 16 Mar 1995, *J.R.Hernández 95-069* (BPI 841101) [II-III].

LAMIACEAE

Puccinia farinacea Long[1]

on *Salvia rypara* Briq.[A]; **Tucumán:** San Pedro de Colalao, 2 Apr 1994, *J.F.Hennen & M.M.Hennen 94-068* (LIL 54807, BPI) [II-

III]; San Pedro de Colalao, 1 Apr 1994, *J.F. Hennen & M.M.Hennen 94-063* (LIL 54805, BPI) [II-II]; San Pedro de Colalao, 2 Apr 1994, *J.F.Hennen & M.M.Hennen 94-074* (LIL 54806, BPI) [II-III].

on *Salvia* sp.; **Jujuy:** Palma Sola, 12 Apr 1994, *J.F.Hennen & L.D.Ploper 94-134* (LIL 54808, BPI 841059) [II III].

Puccinia giberti Speg.

on *Hyptis* sp.; **Tucumán:** Tafí del Valle, 6 Apr 1993, *J.F.Hennen & J.R.Hernández 93-125* (LIL 54760, BPI 841020) [II-III].

Puccinia hyptidis-mutabilis Mayor[A]

on *Hyptis mutabilis* (Rich.) Briq.[AR]; **Salta:** Cafayate, 8 Apr 1994, *J.F.Hennen, M.M. Hennen & J.R.Hernández 94-102* (LIL 54810, BPI) [II-X]; Cafayate, 9 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R. Hernández 94-113* (LIL 54811, BPI) [II-X]. **Tucumán:** Cruz Alta, San Agustín, 30 Mar 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-037* (LIL 54809, BPI) [II-X]; El Manantial, 15 May 1996, *J.R.Hernández 96-093* (BPI 841159) [II-X]; San Javier, Parque Sierras de San Javier, La Cascada., 29 Mar 1996, *J.R.Hernández 96-018* (BPI 841125) [II-X].

on *Hyptis* sp.[AR]; **Tucumán:** Alta Gracia, 19 Nov 1997, *J.R.Hernández 97-088* (BPI) [II-X]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-077* (LIL 54813, BPI) [II-X]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-066* (LIL 54812, BPI) [II-X-III]; NW of San Miguel de Tucumán, 31 Mar 1993, *J.F.Hennen & J.R.Hernández 93-085* (LIL 54814, BPI) [II-X].

Puccinia menthae Pers.[1]

on *Mentha pulegium* L.; **Tucumán:** Valle de Las Salas, bank of Río Las Salas, 3 Nov 1997, *J.R.Hernández 97-150* (BPI 841247) [II].

on *Mentha* sp.; **Tucumán:** Dept. Capital, 15 Sep 1995, *J.R.Hernández 95-087* (BPI) [II].

Puccinia pallidissima Speg.[T]

on *Stachys gilliesii* Benth.[S]; **Tucumán:** Dept. Capital, Quinta Agronómica, 15 Apr 1995, *J.R.Hernández 95-074* (BPI 841105) [III].

on *Stachys* sp.; **Tucumán:** Yerba Buena, 29 Mar 1993, *J.R.Hernández 93-044* (LIL 54815, BPI) [III].

LILIACEAE

Puccinia allii F. Rudolfi[1]

on *Allium sativum* L.; **Tucumán:** Leales, 15 Aug 1992, *L.D.Ploper & N.V.de Ramallo s.n.* (BPI 840992) [II-III].

MALPIGHIACEAE

Puccinia heteropteridis Thüm.[C, I]

on *Janusia guaranitica* (H. St.-Hil.) A. Juss.[S]; **Catamarca:** road to El Rodeo, camping area, 29 Nov 1997, *J.R.Hernández 97-116* (BPI) [II]; W side of Catamarca, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-034* (BPI 841183) [II-III]. **Tucumán:** San Pedro de Colalao, 1 Apr 1994, *J.F.Hennen & M.M.Hennen 94-056* (LIL 54861, BPI 841027) [III].

MALVACEAE

Catenulopsora praelonga (Speg.) Buriticá[A]

on *Pavonia malvacea* (Vell.) Krapov. & Cristoval[S]; **Tucumán:** San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-143* (LIL 54863, BPI) [II]; San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-025* (LIL 54862, BPI 840997) [II-III].

Puccinia heterospora Berk. & M.A. Curtis[I]

on *Abutilon* sp.; **Tucumán:** 19.5 km W of San Miguel de Tucumán, mtn, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-007* (LIL 54864, BPI) [III].

on *Anoda cristata* (L.) Schltdl.; **Jujuy:** Capital, 15 Apr 1994, *J.R.Hernández 94-167* (BPI) [III]. **Tucumán:** San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-161* (LIL 54867, BPI) [III]; San Miguel de Tucumán, 23 Jun 1995, *J.R.Hernández 95-081* (BPI) [III]; San Pedro de Colalao, 2 Apr 1994, *J.F.Hennen & M.M.Hennen 94 076* (LIL 54866, BPI) [III]; San Pedro de Colalao, 31 Mar 1994, *J.F.Hennen & M.M.Hennen 94-042* (LIL 54865, BPI) [III].

on *Gaya gaudichaudiana* A. St.-Hil.; **Tucumán:** Cruz Alta, San Agustín, 30 Mar 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-036* (LIL 54868, BPI) [III]; Cruz Alta, San Agustín, 30 Mar 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-040*

(LIL 54869, BPI) [III]; Dept. Trancas, Vipos, 28 Mar 1996, *J.R.Hernández 96-003* (BPI) [III].

on *Gaya* sp.; **Tucumán:** Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-068* (LIL 54871, BPI) [III].

on *Sida prostrata* Cav.; **Tucumán:** J.B. Alberdi, S of Escaba Dike, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-008* (BPI 841167) [III]

on *Sida spinosa* L.; **Tucumán:** Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-064* (LIL 54870, BPI 841004) [III].

Puccinia malvacearum Bertero ex Mont.

on *Malvastrum coromandelianum* (L.) Garcke; **Salta:** Cafayate, 8 Apr 1994, *J.F. Hennen, M.M.Hennen & J.R.Hernández 94-104* (LIL 54873, BPI) [III]. **Tucumán:** Dept. Trancas, Vipos, 28 Mar 1996, *J.R.Hernández 96-008* (BPI 841120) [III]; Dept. Trancas, Vipos, 30 Mar 1995, *J.R Hernández 95-046* (BPI) [III]; J.B. Alberdi, road to Escaba, 28 Nov 1997, *J.R. Hernández 97-094* (BPI 841216) [III]; San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-152* (LIL 54874, BPI) [III]; San Javier, Parque Sierras de San Javier, La Cascada., 29 Mar 1996, *J.R. Hernández 96-019* (BPI) [III]; San Pedro de Colalao, 31 Mar 1994, *J.F.Hennen & M.M.Hennen 94-041* (LIL 54872, BPI) [III].

on *Malvastrum* sp.; **Tucumán:** NW of San Miguel de Tucumán, 31 Mar 1993, *J.F. Hennen & J.R.Hernández 93-082* (LIL 54875, BPI) [III].

on *undtn.*; **Tucumán:** Horco Molle, 20 Apr 1992, *J.R.Hernández 92-007* (BPI) [III]; Horco Molle, 17 Sep 1997, *J.R.Hernández 97-080* (BPI 841208) [III].

Puccinia platyspora (Speg.) H.S. Jacks. & Holw.

on *Alcea rosea* L.[A]; **Jujuy:** Tilcara, 3 Feb 1996, *J.R.Hernández 96-001* (BPI 841116) [III].

on *Alcea* sp.[A]; **Tucumán:** San Miguel de Tucumán, 15 Apr 1991, *J.R.Hernández 91 003* (BPI) [III].

on *Modiolastrum malvifolium* (Griseb.) K Schmann; **Catamarca:** Balcozna, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-021* (BPI) [III]; near Balcozna, 28 Nov 1997, *J.R.Hernández 97-114* (BPI) [III]; W side of Catamarca, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-025* (BPI) [III]. **Salta:** Posta de Yatasto, 6 Dec 1997, *J.R.Hernández 97-156* (BPI 841252) [III]. **Tucumán:** Cruz Alta, 15 Mar 1996, *J.R.Hernández 96-090* (BPI) [III]; El Siambón, river next to monastery, 3 Nov 1997, *J.R.Hernández 97-144* (BPI 841242) [III]; Horco Molle, 15 May 1995, *J.R.Hernández 95-080* (BPI 841107) [III]; Lules, 16 Nov 1996, *J.R.Hernández 96-065* (BPI) [III]; San Pedro de Colalao, 31 Mar 1994, *J.F.Hennen & M.M.Hennen 94-043* (LIL 54876, BPI) [III].

on *Modiolastrum* sp.; **Tucumán:** NW of San Miguel de Tucumán, 31 Mar 1993, *J.F. Hennen & J.R.Hernández 93-089* (LIL 54879, BPI) [III]; San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D. Ploper & J.R.Hernández 93-024* (LIL 54877, BPI) [III]; Yerba Buena, 29 Mar 1993, *J.R.Hernández 93-045* (LIL 54878, BPI) [III].

on *Sphaeralcea* sp.; **Catamarca:** Dept. Ambatos, El Rodeo, 14 Nov 1999, *J.R.Hernández 99-006* (BPI 841275) [III]; Dept. Capital, 14 Nov 1999, *J.R.Hernández 99-002* (BPI 841271) [III]; E of La Viña, 24 Sep 1997, *J.F.Hennen & J.R.Hernández 97-062* (BPI) [III]; Rio Las Juntas, 23 Sep 1997, *J.F. Hennen & J.R.Hernández 97-050* (BPI) [III]. **Salta:** Cafayate, 8 Apr 1994, *J.F. Hennen, M.M.Hennen & J.R.Hernández 94-103* (LIL 54880, BPI 841043) [III]. **Tucumán:** Dept. Trancas, Vipos, 28 Mar 1996, *J.R.Hernández 96-004* (BPI) [III].

on *Tarasa jorgensenii* (I.M. Johnst.) Krapov.[S]; **Salta:** Cafayate, 9 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-114* (LIL 54881, BPI) [III]

on *undtn.*; **San Luis:** Villa Mercedes, 15 Sep 1992, leg. ? (BPI) [III].

MORACEAE

Phakopsora nishidana S. Ito[A]

on *Ficus carica* L.; **Salta:** Dept. Santa Victoria, La Misión, 30 Jun 1996, *J.R.Hernández 96-051* (BPI 841139) [II]; Pichanal, 2 Apr 1993, *J.F.Hennen & L.D.Ploper 93-101* (LIL 54883, BPI) [II]. **Tucumán:** Dept. Capital, 30 Mar 1993, *J.R.Hernández 93-048* (LIL 54882, BPI) [II]; San Miguel de Tucumán, 12 May 1991, *J.R.Hernández 91-004* (BPI)

[II]; San Pedro de Colalao, 2 Apr 1994, *J.F.Hennen & M.M.Hennen 94-077* (LIL 54884, BPI) [II].

MYRTACEAE

Puccinia psidii G. Winter

on *Psidium guajava* L.; **Tucumán:** El Corte, 15 Feb 1995, *J.R.Hernández 95-065* (BPI) [II]; El Corte, 15 Feb 1995, *J.R.Hernández 95-066* (BPI 841098) [II].

NYCTAGINACEAE

Puccinia bougainvilleae Schröt.[C]

on *Bougainvillea stipitata* Griseb.; **Catamarca:** El Rodeo, 29 Nov 1997, *J.R.Hernández 97-127* (BPI 841232) [I]. **Jujuy:** San Pedro, 2 Apr 1993, *J.F.Hennen & L.D.Ploper 93-106* (LIL 54885, BPI) [0-I-II-III]. **Tucumán:** San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-164* (LIL 54887, BPI) [I-II-III]; San Pedro de Colalao, 16 Jul 1992, *J.R.Hernández & A.Würschmidt 92-008* (BPI) [I]; San Pedro de Colalao, 1 Apr 1994, *J.F.Hennen & M.M.Hennen 94-050* (LIL 54886, BPI 841025) [I-II-III].

ONAGRACEAE

Endophyllum sp.[N]

on *Fuchsia boliviana* Carrière; **Tucumán:** El Corte, 14 Nov 1997, *J.R.Hernández 97-129* (BPI 841233) [III]; Lules, 27 Oct 1996, *J.R.Hernández 96-069* (BPI 841147) [III]; Rt. 367, 13 Sep 1986, *A.Ganem s.n.* (BPI) [III]; Tafí del Valle, 13 Sep 1986, *C.Boero s.n.* (BPI) [III].

Puccinia jussiaeae Speg.[I]

on *Ludwigia* sp.; **Tucumán:** NW of San Miguel de Tucumán, 31 Mar 1993, *J.F.Hennen & J.R.Hernández 93-086* (LIL 54710, BPI 841008) [II-III].

Pucciniastrum epilobii (Chaillet) G.H. Otth

on *Epilobium brasiliese* Hausskn.; **Salta:** Dept. Trancas, Cuesta del Arca, Jan 1897, leg. ? [II-III].

OXALIDACEAE

Puccinia oxalidis Dietel & Ellis

on *Oxalis* sp.; **Jujuy:** San Salvador, 12 Apr 1994, *J.F.Hennen & L.D.Ploper 94-126* (LIL 54889, BPI) [II]. **Tucumán:** Dept. Trancas, Vipos, 28 Mar 1996, *J.R.Hernández 96-005* (BPI) [II]; El Corte, 20 Feb 1995, *J.R. Hernández 95-063* (BPI 841096) [II]; San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-021A* (LIL54888, BPI) [II]; San Pedro de Colalao, 16 Jul 1992, *J.R.Hernández & A.Würschmidt 92-009* (BPI) [II].

PIPERACEAE

Puccinia peperomiae J.C. Lindq.[S]

on *Peperomia* sp.; **Salta:** camino de corniza between Salta and Jujuy, 7 Dec 1997, *J.R. Hernández 97-175* (BPI 841263) [II]; Dept. Santa Victoria, Los Toldos, El Nogalal, 29 Jun 1996, *J.R.Hernández 96-049* (BPI 841138) [II]. **Tucumán:** E slope of Aconquija, road to Tafí del Valle, 11 Nov 1952, *A.T.Hunziker s.n.* [II-III]; Horco Molle, Parque Sierras de San Javier, 29 Mar 1996, *J.R.Hernández 96-020* (BPI 841126) [II]; J.B. Alberdi, S of Escaba Dike, 28 Nov 1997, *J.R.Hernández 97-107* (BPI) [II-III].

POACEAE

Physopella compressa (Mains) Cummins & Ramachar[A]

on *Paspalum* sp.[AR]; **Tucumán:** Yerba Buena, 24 Mar 1993, *J.R.Hernández 93-043* (LIL 54783, BPI 840999) [II].

Puccinia abnormis Henn.

on *Echinochloa cruspavonis* (Kunth) Schult.[S]; **Salta:** Cafayate, 9 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-117* (LIL 54784, BPI 841049) [II-III].

on *Echinochloa* sp.; **Tucumán:** Amberes, 5 May 1989, *L.D.Ploper & G.Würschmidt s.n.* (BPI) [II-III-IV].

Puccinia aristidae Tracy var. **chaetaria** Cumm. & Husain[A]

on *Aristida* sp.[AR]; **Catamarca:** bank of Rio Las Juntas, 23 Sep 1997, *J.F.Hennen & J.R. Hernández 97-040* (BPI 841186) [II-III].

Puccinia brachypodii G.H. Otth var. **poae-nemoralis** (G.H. Otth) Cummins & H.C. Greene

on *Poa* sp.; **Tierra del Fuego:** Est. Fique, 16 Feb 1953, *Ruiz Leal & Roig s.n.* (LPS 22392)[II].

on *Poa stuckertii* (Hack.) Parodi; **Buenos Aires:** Santa Catalina, Oct 1941, *J.C.Lindquist s.n.* (LPS 4895)[II-III].

Puccinia cacabata Arthur & Holw.[I]

on *Chloris gayana* Kunth[AR]; **Salta:** Las Lajitas,

12 Apr 1994, *J.F.Hennen & L.D.Ploper 94-128* (LIL 54785, BPI) [II-III].

on *Chloris polydactyla* (L.) Sw.; **Tucumán:** Dept. Trancas, Vipos, 30 Mar 1995, *J.R. Hernández 95-042* (BPI 841085) [II-III].

Puccinia chaetochloae Arthur[A]

on *Setaria lachnea* (Nees) Kunth[A]; **Salta:** Las Lajitas, 12 Apr 1994, *J.F.Hennen & L.D. Ploper 94-129* (LIL 54802, BPI) [II].

on *Setaria parviflora* (Poir.) Kerguélen[A]; **Tucumán:** Cruz Alta, San Agustín, 30 Mar 1994, *J.F.Hennen, M.M.Hennen & J.R. Hernández 94-034* (LIL 54803, BPI) [II].

on *Setaria* sp.[AR]; **Catamarca:** W side of Catamarca, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-026* (BPI 841177) [II]. **Tucumán:** Cruz Alta, 23 Jun 1995, *J.R. Hernández 95 083* (BPI) [II]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-075* (LIL 54804, BPI) [II]; Monte Redondo, 31 Mar 1996, *J.R.Hernández 96-086* (BPI) [II].

Puccinia chloridis Speg.

on *Chloris virgata* Sw.; **Salta:** Cafayate, 9 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R. Hernández 94-118* (LIL 54786, BPI 841050) [II-III].

Puccinia coronata Corda var. **rangiferina** (S. Ito) Cummins[A]

on *Avena sativa* L.[AR]; **Tucumán:** Dept. Capital, Quinta Agronómica, 20 Oct 1994, *J.R.Hernández 94-172* (BPI 841077) [II-III].

Puccinia cynodontis Lacroix ex Desm.[A]

on *Cynodon dactylon* L.; **Salta:** Cafayate, 9 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R Hernández 94-109* (LIL 54787, BPI 841044) [II-III].

Puccinia inclita Arthur[A]

on *Ichnanthus minarum* (Nees) Döll[A]; **Tucumán:** NW of San Miguel de Tucumán, 31 Mar 1993, *J.F.Hennen & J.R.Hernández 93-083* (LIL 54799, BPI 841007) [II-III]; San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-138A* (LIL 54801, BPI) [II-III]; San Javier, Parque Sierras de San Javier, La Cascada., 29 Mar 1996, *J.R.Hernández 96-015* (BPI) [II-III]; Tafí del Valle, 6 Apr 1993, *J.F.Hennen & J.R. Hernández 93-126A* (LIL 54780, BPI) [III].

Puccinia leptochloae Arthur[I]

on *Leptochloa mucronata* (Michaux) Kunth[A]; **Tucumán:** Dept. Cruz Alta, San Agustín, Monte Redondo, 29 Mar 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94 026* (LIL 54788, BPI 841021) [II-III].

Puccinia levis (Sacc.& Bizz.) Magnus var. **panici-sanguinalis** (Rangel) Ramachar & Cummins[A]

on *Ichnanthus minarum* (Nees) Döll[A]; **Tucumán:** San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94 138* (LIL 54801, BPI 841063) [II]; Tafí del Valle, 6 Apr 1993, *J.F.Hennen & J.R. Hernández 93-126* (LIL 54800, BPI) [II-III].

on *Panicum* sp.[AR]; **Catamarca:** Rio Las Juntas, camping area, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-037* (BPI) [II-III]; W side of Catamarca, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-032* (BPI 841181) [II-III]; W side of Catamarca, 23 Sep 1997, *J.F. Hennen & J.R.Hernández 97 031* (BPI 841180) [II-III].

Puccinia melanocephala Syd. & P. Syd.

on *Saccharum officinarum* L.; **Jujuy:** San Pedro, 12 Apr 1994, *J.F.Hennen & L.D. Ploper 94-124* (LIL 54789, BPI) [II-III]. **Tucumán:** Dept. Capital, 23 Jun 1996, *J.R.Hernández 96-082* (BPI 841153) [II III]; Santa Lucia, 15 Mar 1988, *L.D.Ploper & G.Würschmidt s.n.* (BPI) [III].

Puccinia oahuensis Ellis & Everh.[A I]

on *Digitaria insularis* (L.) Fedde[AR]; **Jujuy:** Pampa Blanca, 1 Apr 1993, *J.F.Hennen & L.D.Ploper 93-098* (LIL 54791, BPI) [II-III]. **Tucumán:** Dept. Cruz Alta, San Agustín, Monte Redondo, 29 Mar 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-029* (LIL 54792, BPI) [II III]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-071* (LIL 54790, BPI) [II]; Monte Redondo, 31 Mar 1996, *J.R.Hernández 96-087* (BPI) [II-III]; San Pedro de Colalao, 31 Mar 1994, *J.F.Hennen & M.M.Hennen 94-044* (LIL 54793, BPI) [II].

on *Digitaria sanguinalis* (L.) Scop.; **Salta:** between Rosario de la Frontera and Horcones, 11 Apr 1994, *J.F.Hennen & L.D.Ploper 94-122* (LIL 54794, BPI 841053) [II-III].

Puccinia purpurea Cooke[I]

on *Sorghum cafrorum* (Thunb.) P. Beauv.[A];

Tucumán: Horco Molle, Parque Sierras de San Javier, 29 Mar 1996, *J.R.Hernández 96-025* (BPI) [II]; Monte Redondo, 23 Oct 1996, *J.R.Hernández 96-080* (BPI) [II].

on *Sorghum halepense* (L.) Pers.; **Tucumán:** Alta Gracia, 19 Nov 1997, *J.R.Hernández 97-089* (BPI 841212) [II-III]; Cevil Pozo, 12-15 km E of San Miguel de Tucumán, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-054* (LIL 54795, BPI) [II]; Dept. Trancas, Vipos, 28 Mar 1996, *J.R.Hernández 96-010* (BPI) [II-III]; San Pedro de Colalao, 31 Mar 1994, *J.F.Hennen & M.M.Hennen 94-049* (LIL 54796, BPI) [II].

Puccinia recondita Roberge ex Desm.

on *Bromus* sp.; **Tucumán:** Tafí del Valle, 15 Jul 1994, *J.R.Hernández 94-169* (BPI) [II]; Tafí del Valle, 6 Apr 1993, *J.F.Hennen & J.R. Hernández 93-119* (LIL 54797, BPI) [II-III].

on *Bromus unioloides* Kunth; **Tucumán:** El Manantial, 8 Oct 1995, *J.R.Hernández 95-041* (BPI 841084) [II].

on *Triticum aestivum* L.; **Tucumán:** Dept. Burruyacu, Loc. La Ramada, Finca Los Lapachos, 19 Sep 1999, *J.R.Hernández 99-011* (BPI 841279) [II-III].

Puccinia sorghi Schwein.

on *Zea mays* L.; **Salta:** Between Rosario de la Frontera and Horcones, 11 Apr 1994, *J.F. Hennen & L.D.Ploper 94-123* (LIL 54798, BPI 841054) [III]. **Tucumán:** Dept. Capital, 14 May 1995, *J.R.Hernández 95-050* (BPI 841091) [III]; Dept. Capital, 8 Mar 1988, *L.D.Ploper & G.Würschmidt s.n.* (BPI) [II]; El Colmenar, 14 Jun 1989, *L.D.Ploper & G.Würschmidt 89-003* (BPI) [II-III].

Puccinia sp.[N]

on *Ichnanthus minarum* (Nees) Döll[A]; **Tucumán:** San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-138B* (LIL 54801, BPI) [II-III].

Puccinia substriata Ell. & Barth.

on *Digitaria* sp.; **Tucumán:** Dept. Capital, 10 Mar 1996, *J.R.Hernández 96-079* (BPI 841151) [II-III].

Uromyces setariae-italicae Yosh.[I]

on *Setaria* sp.; **Tucumán:** San Javier, Parque Sierras de San Javier, La Cascada., 29 Mar 1996, *J.R.Hernández 96-017* (BPI 841124) [II-III].

POLYGONACEAE

Cerotelium sp.[N]

on *Ruprechtia apetala* Wedd.[G]; **Tucumán:** San Pedro de Colalao, 1 Apr 1994, *J.F.Hennen & M.M.Hennen 94-051* (LIL 54890, BPI) [II-III].

on *Ruprechtia laxiflora* Meisn.[G]; **Tucumán:** Dept. Capital, 15 Aug 1994, *J.R.Hernández 94-135* (LIL 54893, BPI 841060) [II].

on *Ruprechtia* sp.[G]; **Tucumán:** SW of J.B. Alberdi, 22 Sep 1997, *J.F.Hennen & J.R Hernández 97-004* (BPI 841163) [II].

Puccinia polygoni-amphibii Pers.:Pers.[C,S,T]

on *Polygonum acuminatum* Kunth; **Salta:** Cafayate, 9 Apr 1994, *J.F.Hennen, M.M. Hennen & J.R.Hernández 94-116* (LIL 54892, BPI) [II]. **Tucumán:** San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R. Hernández 93-040* (LIL 54891, BPI) [II].

on *Polygonum hydropiperoides* Michx.; **Catamarca:** El Rodeo, 29 Nov 1997, *J.R. Hernández 97-123* (BPI 841229) [II]. **Salta:** Posta de Yatasto, 6 Dec 1997, *J.R.Hernández 97-157* (BPI 841253) [II]. **Tucumán:** road to Villa Nougués, 5 May 1995, *J.R.Hernández 95-034* (BPI 841081) [II].

on *Polygonum* sp.; **Catamarca:** E of La Viña, 24 Sep 1997, *J.F.Hennen & J.R.Hernández 97-059* (BPI) [II]; W side of Catamarca, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-030* (BPI 841179) [II]. **Tucumán:** Road to Balcozna, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-012* (BPI) [II].

Uromyces crassipes Dietel & Neger[T]

on *Rumex* sp.; **Tucumán:** El Manantial, Fac. de Agronomía, 10 Oct 1999, *J.R.Hernández 99-010* (BPI 841278) [II].

PORTULACACEAE

Puccinia leptochloae Arthur & Fromme[J,T]

on *Talinum paniculatum* (Jack.) Gaertn.; **Jujuy:** road to Parque Nacional Calilegua, 8 Dec 1997, *J.R.Hernández 97-177* (BPI 841265) [0-I]. **Tucumán:** Dept. Capital, 12 Mar 1997, *M.de la Vega s.n.* (BPI 841249) [0-I].

PTERIDACEAE

Desmella anemiae Syd. & P. Syd.[A]

on *Pteris deflexa* Link[A]; **Tucumán:** SW of J.B. Alberdi, 22 Sep 1997, *J.F.Hennen & J.R. Hernández 97-005* (BPI 841164) [II].

on *Pteris* sp.[AR]; **Tucumán:** J.B. Alberdi, S of Escaba Dike, 28 Nov 1997, *J.R.Hernández 97-110* (BPI) [II].

RANUNCULACEAE

Baeodromus ranunculi J.R. Hern. & J.F. Hennen
on *Ranunculus flagelliformis* Sm.; **Catamarca:** Dept. Ambatos, El Rodeo, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-046* (BPI 841190) [III]; Dept. Ambatos, El Rodeo, 14 Nov 1999, *J.R.Hernández 99-008* (BPI 746516) [III].

Puccinia recondita Roberge ex Desm.
on *Clematis montevidensis* Spreng.[?]; **Catamarca:** El Rodeo, 29 Nov 1997, *J.R.Hernández 97-124* (BPI) [0]. **Tucumán:** Alta Gracia, 19 Nov 1997, *J.R.Hernández 97 091* (BPI) [0 I]; El Corte, 15 Feb 1995, *J.R.Hernández 95-068* (BPI 841100) [0 I]; El Siambón, river next to monastery, 3 Nov 1997, *J.R.Hernández 97-148* (BPI) [0]; J.B. Alberdi, road to Escaba, bank of creek, 28 Nov 1997, *J.R.Hernández 97-101* (BPI) [0-I]; NW of San Miguel de Tucumán, 31 Mar 1993, *J.F.Hennen & J.R.Hernández 93-081* (LIL 54895, BPI) [0 I]; NW of San Miguel de Tucumán, 31 Mar 1993, *J.F. Hennen & J.R.Hernández 93-087* (LIL 54894, BPI) [0-I].
on *Clematis sericea* Michx.[?]; **Tucumán:** San Javier, Parque Sierras de San Javier, La Cascada., 29 Mar 1996, *J.R.Hernández 96-016* (BPI 841123) [0-I].

RHAMNACEAE

Phakopsora zizyphi-vulgaris Dietel[A]
on *Zizyphus mistol* Griseb.[?]; **Tucumán:** Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R Hernández 93-079* (LIL 54896, BPI 841006) [II].

ROSACEAE

Frommeella mexicana var. **indicae** J.W. McCain & J.F. Hennen[A]
on *Duchesnea indica* (Andrews) Focke[A]; **Buenos Aires:** Ensanada, date ?, *G.A.Costa & B.L.Ronco s.n.* [II]. **Salta:** Dept. Santa Victoria, Los Toldos, 28 Jun 1996, *J.R. Hernández 96-035* (BPI 841133) [II-III]. **Tucumán:** Dept. Trancas, El Potrero, 28 Oct 1996, *J.R.Hernández 96-068* (BPI) [II]; Dept. Trancas, El Potrero, 28 Oct 1996, *J.R.Hernández 96-067* (BPI 841146) [III]; NW of San Miguel de Tucumán, 31 Mar 1993, *J.F.Hennen & J.R.Hernández 93-095* (LIL 54898, BPI) [II]; Raco, 3 Nov 1997, *J.R.Hernández 97-140* (BPI) [II]; Road to Balcozna, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-014* (BPI 841170) [II]; San Javier, 27 Mar 1993, *J.F.Hennen, L.D. Ploper & J.R.Hernández 93-038* (LIL 54897, BPI) [II]; San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-157* (LIL 54899, BPI 841072) [II].

Gerwasia imperialis (Speg.) J.C. Lindq.
on *Rubus boliviensis* Focke[?]; **Tucumán:** Horco Molle, Parque Sierras de San Javier, 6 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R. Hernández 94-085* (LIL 54902, BPI) [I-III]; San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R. Hernández 93-030A* (LIL54903, BPI 840998B) [0-I]; San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-026* (BPI) [0-I-III]; San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-037* (LIL 54901, BPI) [I]
on *Rubus imperialis* Cham. & Schltdl.; **Salta:** camino de corniza between Salta and Jujuy, 7 Dec 1997, *J.R.Hernández 97-174* (BPI) [0-I]; Dept. Santa Victoria, Los Toldos, El Nogalal, 29 Jun 1996, *J.R. Hernández 96-045* (BPI) [0-I-II-III]; Dept. Santa Victoria, Los Toldos, El Nogalal, 29 Jun 1996, *J.R.Hernández 96-046* (BPI) [0-I-III]. **Tucumán:** El Siambón, river next to monastery, 3 Nov 1997, *J.R.Hernández 97-146* (BPI 841244) [0-I]; Horco Molle, 14 Nov 1997, *J.R.Hernández 97-138* (BPI) [0-I-III].

Kuehneola loeseneriana (Henn.) H.S. Jacks. & Holw.
on *Rubus boliviensis* Focke[A]; **Tucumán:** San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R. Hernández 93-030* (LIL 54900, BPI 840998A) [0 I II-III].

Phragmidium mucronatum (Pers.) Schlecht.[?]
on *Rosa* sp.; **Salta:** Dept. Santa Victoria, Los Toldos, 28 Jun 1996, *J.R.Hernández 96-036* (BPI 841134) [II-III].

Phragmidium tuberculatum J. Müller[I]
on *Rosa* sp.; **Tucumán:** Dept. Capital, 17 Dec

1995, *J.R.Hernández 95-091* (BPI 841113) [II].

Tranzschelia discolor (Fuckel) Tranzschel & Litv.[S]
on *Prunus armeniaca* L.; **Salta:** Dept. Santa Victoria, Los Toldos, 28 Jun 1996, *J.R. Hernández 96-029* (BPI) [II-III]. **Tucumán:** Raco, 23 Apr 1996, *J.R.Hernández 96-026* (BPI 841130) [II-III].
on *Prunus domestica* L.; **Salta:** Dept. Santa Victoria, Los Toldos, 28 Jun 1996, *J.R. Hernández 96-034* (BPI) [II]. **Tucumán:** Dept. Capital, 10 Apr 1996, *J.R.Hernández 96-083* (BPI 841154) [II]; San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R. Hernández 94-147* (LIL 54904, BPI) [II-III].
on *Prunus persica* (L.) Batsch; **Salta:** Dept. Santa Victoria, La Misión, 30 Jun 1996, *J.R.Hernández 96-060* (BPI) [II-III]; Dept. Santa Victoria, Los Toldos, 28 Jun 1996, *J.R.Hernández 96-030* (BPI) [II]. **Tucumán:** El Corte, 15 Nov 1997, *J.R.Hernández 97-083* (BPI 841209) [II]; Horco Molle, Parque Sierras de San Javier, 6 Apr 1994, *J.F. Hennen, M.M.Hennen & J.R.Hernández 94-093* (LIL 54906, BPI) [II-III]; San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-021* (LIL 54905, BPI) [II]

RUBIACEAE

Uredo sp.[N]
on *Psychotria carthagenensis* Jacq.; **Tucumán:** El Corte, 15 Nov 1997, *J.R.Hernández 97-084* (BPI 841210) [II]; El Corte, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R. Hernández 93-002* (LIL 54907, BPI) [II]; Horco Molle, 14 Nov 1997, *J.R.Hernández 97-133* (BPI 841236) [II]; Horco Molle, Parque Sierras de San Javier, 29 Mar 1996, *J.R.Hernández 96-021* (BPI 841127) [II]; Horco Molle, Parque Sierras de San Javier, 6 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R. Hernández 94-089* (LIL 54908, BPI) [II].

Uromyces holmbergii Speg.[T]
on *Diodia dasycephala* Cham. & Schltdl.; **Tucumán:** El Corte, 15 Feb 1995, *J.R. Hernández 95-064* (BPI 841097) [II III]; San Pedro, 16 Mar 1996, *O.Baino s.n.* (BPI 841150) [II-III]; Tafí del Valle, 6 Apr 1993, *J.F.Hennen & J.R.Hernández 93-124* (LIL 54909, BPI) [II-III].

SALICACEAE

Melampsora epitea (Kunze & J.C. Schmidt) Thüm.[A]
on *Salix babylonica* L.[AR]; **Salta:** Cafayate, 8 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-097* (LIL 54914, BPI 841039) [II]; Metán, 2 Apr 1993, *J.F.Hennen & L.D.Ploper 93-112* (LIL 54911, BPI) [II]. **Tucumán:** Dept. Capital, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-041A* (LIL54910, BPI) [II]; Dept. Capital, 4 Apr 1994, *J.F.Hennen & J.R. Hernández 94-081* (LIL 54913, BPI) [II]; San Pedro de Colalao, 3 Apr 1994, *J.F.Hennen & M.M. Hennen 94-079* (LIL 54912, BPI) [II].
on *Salix caprea* L.[AR]; **Tucumán:** Dept. Capital, 17 Dec 1995, *J.R.Hernández 95-096* (BPI 841115) [II].
on *Salix humboldtiana* Willd.[AR]; **Tucumán:** San Javier, 27 Mar 1993, *J.F.Hennen, L.D. Ploper & J.R.Hernández 93-020* (LIL 54915, BPI) [II]; San Pedro de Colalao, 2 Apr 1994, *J.F.Hennen & M.M.Hennen 94-078* (LIL 54916, BPI) [II].

Melampsora larici-populina Kleb.[S]
on *Populus nigra* L.; **Salta:** Cafayate, 8 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R. Hernández 94-100* (LIL 54917, BPI 841041) [II].
on *Populus* sp.; **Santa Fe:** 1941, *J.R.Weir s.n.* [II].

Melampsora medusae Thüm.
on *Populus* sp.; **Buenos Aires:** La Plata, Dec 1923, *J.R.Weir s.n.* [II]; Buenos Aires, S.A., 25 Dec 1923, *J.R.Weir s.n.* [II].

Melampsora populnea (Pers.) P. Karst.
on *Populus alba* L.; **Buenos Aires:** La Plata, Dec 1923, *J.R.Weir s.n.* [II]; **Córdoba:** Capital, 9 Nov 1997, *J.R.Hernández 97-069* (BPI 841202) [II]; Santa Fe, 1941, *E.Schiel s.n.* [II].

SAPINDACEAE

Puccinia arechavaletae Speg.[I]
on *Serjania marginata* Casar.[S]; **Tucumán:** El Corte, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-005* (LIL 54918, BPI 840993) [M-III].

Skierka sp.[N]
on *Cupania vernalis* Cambess.[A]; **Tucumán:** Dept. Trancas, Rt. 9, km 1364, 26 Oct 1995, *J.R.Hernández 95-056* (BPI) [II-III]; El Corte, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-004* (LIL 54919, BPI)

[II]; Horco Molle, 14 Nov 1997, *J.R. Hernández 97-135* (BPI 841238) [III].

SCROPHULARIACEAE

Uredo sibthorpiae J.C. Lindq

on *Sibthorpia conspicua* Diels; **Tucumán:** Yerba Buena, 15 Feb 1996, *J.R.Hernández 96-084* (BPI 841155) [II].

SOLANACEAE

Aecidium sp.

on *Solanum riparium* Pers.; **Salta:** Quebrada de San Lorenzo, 6 Dec 1997, *J.R.Hernández 97-164* (BPI 841260) [0-I]. **Tucumán:** J.B Alberdi, road to Escaba, shrine, 28 Nov 1997, *J.R.Hernández 97-105* (BPI 841222) [0-I].

on *Solanum tucumanense* Griseb.; **Salta:** road to Parque del Rey, 6 Dec 1997, *J.R Hernández 97-159* (BPI 841255) [0 I].

on *Vassobia breviflora* (Sendtner) Hunz.; **Catamarca:** El Portezuelo, 30 Nov 1997, *J.R.Hernández 97-128* (BPI) [I]; El Rodeo, 29 Nov 1997, *J.R.Hernández 97-125* (BPI 841230) [0-I].

Aecidium sp.

on *Cestrum parqui* L'Hér.; **Tucumán:** San Miguel deTucumán, 15 Aug 1995, *J.R.Hernández 95-085* (BPI 841110) [II].

Chrysocyclus cestri (Dietel & Henn.) Syd.

on *Cestrum strigilatum* Ruiz & Pav.; **Tucumán:** 19.5 km W of San Miguel de Tucumán, mtn, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-012* (LIL 54922, BPI) [III]; Dept. Trancas, Rt. 9, km 1364, 26 Oct 1995, *J.R.Hernández 95-057* (BPI) [III]; El Corte, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-003* (LIL 54921, BPI) [III-IV]; Horco Molle, 14 Nov 1997, *J.R.Hernández 97-131* (BPI 841235) [III]; Horco Molle, 17 Sep 1997, *J.R.Hernández 97-081* (BPI) [III]; Horco Molle, Parque Sierras de San Javier, 6 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-090* (LIL 54923, BPI) [III]; San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-145* (LIL 54924, BPI 841068) [III].

Endophyllum pampeanum (Speg.) J.C. Lindq.

on *Salpichroa origanifolia* (Lam.) Baill.; **Catamarca:** Dept. Ambatos, El Rodeo, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-047* (BPI) [III]; Dept. Ambatos, El Rodeo, El Nogalal, 23 Sep 1997, *J.F.Hennen & J.R.Hernández 97-048* (BPI) [III]; Los Altos, 15 Dec 1975, *A.Villegas s.n.* [III]. **Tucumán:** Dept. Trancas, Rt. 9, km 1364, 26 Oct 1995, *J.R.Hernández 95-054* (BPI) [III].

Puccinia araucana Dietel & Neger

on *Cestrum* sp.; **Salta:** camino de corniza between Salta and Jujuy, 7 Dec 1997, *J.R. Hernández 97-176A* (BPI 841264) [I]. **Tucumán:** San Pedro de Colalao, 1 Apr 1994, *J.F.Hennen & M.M.Hennen 94-052* (LIL 54920, BPI) [I].

Puccinia incondita Arthur

on *Solanum abutiloides* (Griseb.) Bitter & Lillo; **Tucumán:** San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-142* (LIL 54928, BPI 841066) [III].

Puccinia negeriana Dietel

on *Lycopersicon esculentum* Mill.; **Tucumán:** Jun 1987, *L.D.Ploper s.n.* (LIL 54925, BPI 840989) [M-III].

Puccinia pampeana Speg.

on *Salpichroa origanifolia* (Lam.) Baill.; **Tucumán:** El Manantial, 31 Mar 1994, *J.R.Hernández 94-166* (BPI) [III III]; Horco Molle, 13 Sep 1997, *J.R.Hernández 97-066* (BPI 841200) [III-III]; Horco Molle, 17 Sep 1997, *J.R.Hernández 97-077* (BPI 841206) [III-III]; NW of San Miguel de Tucumán, 31 Mar 1993, *J.F.Hennen & J.R.Hernández 93-094* (LIL 54926, BPI) [III-III].

Puccinia paradoxapoda Speg.

on *Grabowskia schizocalyx* Dammer; **Salta:** Cafayate, 9 Apr 1994, *J.F.Hennen, M.M. Hennen & J.R.Hernández 94-119* (LIL 54927, BPI 841051) [II III].

Uromyces cestri Mont.

on *Cestrum lorentzianum* Griseb.; **Catamarca:** El Rodeo, 29 Nov 1997, *J.R.Hernández 97-122* (BPI) [II]; N of Catamarca, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-020* (BPI 841174) [II]. **Tucumán:** Alta Gracia, 19 Nov 1997, *J.R.Hernández 97-090* (BPI) [II]; Dept. Trancas, 27 Oct 1995, *J.R.Hernández 95-060* (BPI) [II]; San Pedro de Colalao, 31 Mar 1994, *J.F.Hennen & M.M.Hennen 94 045* (LIL 54937, BPI) [II].

on *Cestrum parqui* L'Hér.; **Salta:** Calayate, 8

Apr 1994, *J.F.Hennen & J.R.Hernández 94-099* (LIL 54929, BPI) [II-III]; Cafayate, 8 Apr 1994, *J.F.Hennen & J.R.Hernández 94-099B* (LIL54931, BPI) [II]; Cafayate, 8 Apr 1994, *J.F.Hennen & J.R.Hernández 94-099A* (LIL54930, BPI 841040) [II-III]. **Tucumán:** Dept. Capital, 15 Dec 1990, *J.R.Hernández 90-002* (BPI) [II].

on *Cestrum* sp.; **Salta:** camino de corniza between Salta and Jujuy, 7 Dec 1997, *J.R.Hernández 97-176* (BPI) [II]. **Tucumán:** Cevil Pozo, 12-15 km E of San Miguel de Tucumán, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-053* (LIL 54934, BPI) [II]; Cruz Alta, San Agustín, 30 Mar 1994, *J.F.Hennen, M.M.Hennen & J.R. Hernández 94-033* (LIL 54936, BPI) [II]; Horco Molle, Parque Sierras de San Javier, 6 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-091B* (LIL54733, BPI) [II]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-067* (LIL 54935, BPI) [II]; San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-023* (LIL 54932, BPI) [II]; San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-041* (LIL 54933, BPI) [II]; SW of J.B. Alberdi, 22 Sep 1997, *J.F.Hennen & J.R.Hernández 97-003* (BPI 841162) [II-III].

THELYPTERIDACEAE

Desmella anemiae Syd. & P. Syd.[A]

on *Thelypteris quadrangularis* (Fée) Schelpe[A]; **Tucumán:** El Corte, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-001* (LIL 54938, BPI) [II]; Horco Molle, 17 Sep 1997, *J.R.Hernández 97-076* (BPI) [II]; Horco Molle, Parque Sierras de San Javier, 6 Apr 1994, *J.F.Hennen, M.M. Hennen & J.R.Hernández 94-084* (LIL 54940, BPI) [II]; San Javier, Parque Sierras de San Javier, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-031* (LIL 54939, BPI) [II].

on *Thelypteris* sp.[A]; **Tucumán:** Horco Molle, 14 Nov 1997, *J.R.Hernández 97-137* (BPI 841239) [II-III].

TILIACEAE

Puccinia triumfettae Dietel & Holw.[A]

on *Triumphetta* sp.[A]; **Tucumán:** Horco Molle, Parque Sierras de San Javier, 6 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-083* (LIL 54942, BPI 841036) [III]; Tafí del Valle, 6 Apr 1993, *J.F.Hennen & J.R. Hernández 93-121* (LIL 54941, BPI) [III].

VALERIANACEAE

Aecidium sp.

on *Valeriana* sp.[A]; **Tucumán:** J.B. Alberdi, road to Escaba, bank of creek, 28 Nov 1997, *J.R.Hernández 97-102* (BPI 841220) [0].

VERBENACEAE

Prospodium lippiae (Speg.) Arthur[ST]

on *Aloysia gratissima* (Gillies & Hook.) Tronc.; **Tucumán:** Monte Redondo, 31 Mar 1996, *J.R.Hernández 96-088* (BPI 841157) [II].

on *Aloysia polystachia* (Griseb.) Moldenke; **Salta:** Cafayate, 8 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-098* (LIL 54945, BPI) [II-III]. **Tucumán:** Alderetes, 30 Mar 1993, *J.R.Hernández 93-070* (LIL 54944, BPI) [II]; Dept. Capital, 17 Aug 1994, *J.R.Hernández 94-136* (LIL 54946, BPI 841062) [II-III]; Dept. Capital, 15 Dec 1996, *N.Cantón s.n.* (BPI) [II].

on *Aloysia* sp.; **Tucumán:** Cruz Alta, San Agustín, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-058* (LIL 54950, BPI) [II]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-063* (LIL 54952, BPI) [II]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-080* (LIL 54947, BPI) [II-III]; Las Cejas, 30 Mar 1993, *J.F.Hennen & J.R.Hernández 93-062* (LIL 54951, BPI) [II]; NW of San Miguel de Tucumán, 31 Mar 1993, *J.F.Hennen & J.R.Hernández 93-084* (LIL 54953, BPI) [II].

on *Aloysia virgata* (Ruiz & Pav.) Juss.[AR]; **Salta:** Metán, 2 Apr 1993, *J.F.Hennen & L.D. Ploper 93-104* (LIL 54948, BPI) [II]. **Tucumán:** Cruz Alta, San Agustín, 30 Mar 1994, *J.F.Hennen, M.M.Hennen & J.R.Hernández 94-032* (LIL 54949, BPI 841023) [II-III].

Puccinia lantanae Farl.

on *Lantana* sp.; **Tucumán:** 22 km W of San Miguel de Tucumán, mtn, 27 Mar 1993, *J.F.Hennen, L.D.Ploper & J.R.Hernández 93-017* (LIL 54955, BPI 840994) [III]; El

Manantial, 15 May 1996, *J.R.Hernández 96-094* (BPI) [III]; San Javier, Parque Sierras de San Javier, 23 Jul 1994, *J.R.Hernández 94-163* (LIL 54956, BPI 841073) [III].

on *Lippia alba* (Mill.) N.E.Br.[A]; **Tucumán:** Dept. Capital, 14 May 1995, *J.R.Hernández 95-049* (BPI 841090) [III].

on *Lippia* cfr. *turnerifolia* Cham.[A]; **Tucumán:** Dept. Trancas, 5 May 1995, *J.R.Hernández 95 002* (BPI 841078) [III].

on *Lippia grisebachiana* Moldenke[A]; **Salta:** Dept. Santa Victoria, La Misión, 30 Jun 1996, *J.R.Hernández 96-062C* (BPI 841144) [III]. **Tucumán:** San Pedro de Colalao, 1 Apr 1994, *J.F.Hennen & M.M.Hennen 94-057* (LIL 54954, BPI) [III].

on *Lippia modesta* Briq.[A]; **Tucumán:** J.B. Alberdi, road to Escaba, 28 Nov 1997, *J.R.Hernández 97-100* (BPI) [III].

on *Lippia* sp.; **Salta:** Dept. Santa Victoria, La Misión, 30 Jun 1996, *J.R.Hernández 96-062A* (BPI) [III]. **Tucumán:** J.B. Alberdi, road to Escaba, shrine, 28 Nov 1997, *J.R. Hernández 97-104* (BPI) [III].

on *Lippia turbinata* Griseb.; **Tucumán:** Dept. Trancas, Vipos, 30 Mar 1995, *J.R.Hernández 95-045* (BPI 841088) [III].

VITACEAE

Endophyllum circumscriptum Whetzel & Olive var. **catamarcensis** J.C Lindq.[1]

on *Cissus sicyoides* L.[A]; **Tucumán:** Horco Molle, Parque Sierras de San Javier, 6 Apr 1994, *J.F.Hennen, M.M.Hennen & J.R. Hernández 94-086* (LIL 54957, BPI) [III].

NEW RECORDS

New rust species (N):

Aecidium sp. (on *Dyschoriste* sp.), *Aecidium* sp. (on *Solanum riparium* Pers., *Solanum tucumanense* Griseb., *Vassobia breviflora* (Sendtner) Hunz.), *Cerotelium* sp. (on *Ruprechtia apetala* Wedd., *Ruprechtia laxiflora* Meisn., *Ruprechtia* sp.), *Endophyllum* sp. (on *Fuchsia boliviana* Carrière), *Puccinia* sp. (on *Vernonia fulta* Griseb., *Vernonia* sp.), *Puccinia* sp. (on *Vernonia squamosa* Gardner), *Puccinia* sp. (on *Ichnanthus minarum* (Nees) Döll), *Skierka* sp. (on *Cupania vernalis* Cambess.), *Uredo* sp. (on *Psychotria carthagenensis* Jacq.), *Ypsilospora* sp. (on *Inga edulis* Mart.).

New rust records for Argentina (A):

Aecidium tournefortiae Henn., *Catenulopsora praelonga* (Speg.) Buriticá, *Cionothrix praelonga* (G. Winter) Arthur, *Coleosporium vernoniae* Berk. & M.A. Curtis, *Desmella anemiae* Syd. & P. Syd., *Edythea quitensis* (Lagerh.) H.S.Jackson & Holw., *Frommeella mexicana* var. *indicae* J.W. McCain & J.F. Hennen, *Melampsora epitea* (Kunze & J.C. Schmidt) Thüm., *Melampsoridium hiratsukanum* S. Ito ex Hirats. f., *Phakopsora meibomiae* (Arthur) Arthur, *Phakopsora neocherimoliae* (Cummins) Buriticá & J.F. Hennen, *Phakopsora nishidana* S. Ito, *Phakopsora zizyphi-vulgaris* Dietel, *Phragmopyxis deglubens* (Berk. & M.A. Curtis) Dietel in Engl. & Prantl, *Physopella compressa* (Mains) Cummins & Ramachar, *Prospodium pithecoctenii* (Pazschke) Cummins, *Prospodium singeri* Petr., *Puccinia aristidae* Tracy var. *chaetaria* Cumm. & Husain, *Puccinia bergii* Speg., *Puccinia calcitrapae* DC. var. *centaureae* (DC.) Cummins, *Puccinia chaetochloae* Arthur, *Puccinia cnici-oleracei* Pers., *Puccinia commelinae* Holw., *Puccinia cordiae* Arthur, *Puccinia coronata* Corda var. *rangiferina* (S. Ito) Cummins, *Puccinia exornata* Arthur, *Puccinia hyptidis-*

mutabilis Mayor, *Puccinia inclita* Arthur, *Puccinia incondita* Arthur, *Puccinia lateripes* Berk. & Ravenel, *Puccinia levis* (Sacc.& Bizz.) Magnus var. *panici-sanguinalis* (Rangel) Ramachar & Cummins, *Puccinia ocellifera* Cummins, *Puccinia pelargonii-zonalis* Doidge, *Puccinia proluviosa* H.S. Jacks. & Holw., *Puccinia rata* H.S. Jacks. & Holw., *Puccinia tanaceti* DC. var *tanaceti*, *Puccinia thunbergiae* Cooke, *Puccinia triumfettae* Dietel & Holw., *Puccinia unicolor* Arthur, *Ravenelia cohniana* Henn., *Ravenelia echinata* Lagerh. & Dietel var. *ectypa* (Arthur & Holw.) Cummins, *Ravenelia macrocarpa* Syd. & P. Syd., *Uromyces aspiliae* H.S. Jacks. & Holw., *Uromyces castaneus* P. Syd. & Syd., *Uromyces celosiae* Dietel & Holw., *Uromyces dietelianus* Pazsche, *Uromyces dolichosporus* Dietel & Holw., *Uromyces iresines* Lagerh. ex Syd. & P. Syd., *Uromyces orbicularis* Dietel, *Uromyces sp.*, *Uromyces transversalis* (Thüm.) G. Winter.

New host plant genus for this rust worldwide (G):
Anadenanthera sp. (*Ravenelia cebil* Speg.), *Chaetothylax umbrosus* Nees (*Puccinia justiciae* Puttemans), *Dyschoriste* sp. (*Aecidium* sp.), *Ruprechtia apetala* Wedd. (*Cerotelium* sp.), *Ruprechtia laxiflora* Meisn. (*Cerotelium* sp.), *Ruprechtia* sp. (*Cerotelium* sp.).

New host plant species for this rust worldwide (S):
Athyrium lilloi (Hicken) Alston (*Desmella anemiae* Syd. & P. Syd.), *Baccharis latifolia* Lem. (*Puccinia colossea* Speg.), *Calliandra formosa* (Kunth) Benth. (*Ravenelia echinata* Lagerh. & Dietel var. *ectypa* (Arthur & Holw.) Cummins), *Canna compacta* Roscoe (*Puccinia thaliae* Dietel), *Chamissoa altissima* (Jacq.) Kunth (*Uromyces celosiae* Dietel & Holw.), *Clematis montevidensis* Spreng. (*Puccinia recondita* Roberge ex Desm.), *Clematis sericea* Michx. (*Puccinia recondita* Roberge ex Desm.), *Cologania ovalifolia* Kunth (*Phakopsora meibomiae* (Arthur) Arthur), *Coursetia brachyrhachis* Harms (*Phragmopyxis deglubens* (Berk. & M.A. Curtis) Dietel in Engl. & Prantl), *Desmodium subsericeum* Malme (*Uromyces orbicularis* Dietel), *Echinochloa cruspavonis* (Kunth) Schult. (*Puccinia abnormis* Henn.), *Grabowskia schizocalyx* Dammer (*Puccinia paradoxapoda* Speg.), *Iresine diffusa* Humb. & Bonpl. ex Willd. var. *diffusa* (*Uromyces iresines* Lagerh. ex Syd. & P. Syd.), *Janusia guaranitica* (H. St.-Hil.) A. Juss. (*Puccinia heteropteridis* Thüm.), *Lippia alba* (Mill.) N.E.Br. (*Puccinia lantanae* Farl.), *Lippia cfr. turnerifolia* Cham. (*Puccinia lantanae* Farl.), *Lippia grisebachiana* Moldenke (*Puccinia lantanae* Farl.), *Lippia modesta* Briq. (*Puccinia lantanae* Farl.), *Lonchocarpus lilloi* (Hassl.) Burkart (*Ravenelia lonchocarpiicola* Speg.), *Mimosa debilis* Humb. & Bonpl. ex Willd. var. *debilis* (*Ravenelia mimosae-sensitivae* Henn.), *Parapiptadenia excelsa* (Griseb.) Burkart (*Ravenelia papillosa* Speg.), *Pavonia malvacea* (Vell.) Krapov. & Cristoval (*Catenulopsora praelonga* (Speg.) Buriticá), *Ruellia ciliatiflora* Hook. (*Puccinia lateripes* Berk. & Ravenel), *Ruellia erythropus* (Nees) Lindau (*Puccinia* sp.),

Salvia rypara Briq. (*Puccinia farinacea* Long), *Senecio bravensis* Cabrera (*Coleosporium tussilaginis* (Pers.) Lév.), *Senecio cremeiflorus* Mattf. (*Coleosporium tussilaginis* (Pers.) Lév.), *Senecio otopterus* Griseb. (*Coleosporium tussilaginis* (Pers.) Lév.), *Senecio peregrinus* Griseb. (*Puccinia proluviosa* H.S. Jacks. & Holw.), *Senna subulata* (Griseb.) H.S. Irwin & Barneby (*Ravenelia macrocarpa* Syd. & P. Syd.), *Serjania marginata* Casar. (*Puccinia arechavaletae* Speg.), *Simsia dombeyana* DC (*Puccinia enceliae* Dietel & Holw. var. *aemulans* (Syd. & P. Syd.) Parmelee), *Solanum abutiloides* (Griseb.) Bitter & Lillo (*Puccinia incondita* Arthur), *Solanum riparium* Pers. (*Aecidium* sp.), *Solanum tucumanense* Griseb. (*Aecidium* sp.), *Stachys gilliesii* Benth. (*Puccinia pallidissima* Speg.), *Tarasa jorgensenii* (I.M. Johnst.) Krapov. (*Puccinia platyspora* (Speg.) H.S. Jacks. & Holw.), *Tournefortia rubicunda* DC. (*Uromyces dolichosporus* Dietel & Holw.), *Tripogandra elongata* (G. Mey.) Woodson (*Puccinia commelinae* Holw.), *Vassobia breviflora* (Sendtner) Hunz. (*Aecidium* sp.), *Vernonia fulta* Griseb. (*Puccinia* sp. A), *Vernonia remotiflora* Rich. (*Puccinia cnici-oleracei* Pers.), *Vernonia saltensis* Hieron. (*Puccinia cnici-oleracei* Pers., *Puccinia rata* H.S. Jacks. & Holw.), *Wedelia saltensis* Cabrera (*Uromyces aspiliae* H.S. Jacks. & Holw.), *Zizyphus mistol* Griseb. (*Phakopsora zizyphi-vulgaris* Dietel).

New host plant species for any rust in Argentina (A):

Alcea rosea L. (*Puccinia platyspora* (Speg.) H.S. Jacks. & Holw.), *Alcea* sp. (*Puccinia platyspora* (Speg.) H.S. Jacks. & Holw.), *Alnus acuminata* Kunth (*Melampsoridium hiratsukanum* S. Ito ex Hirats. f.), *Bauhinia forficata* Link (*Uromyces dietelianus* Pazsche), *Carthamus tinctorius* L. (*Puccinia calcitrapae* DC. var. *centaureae* (DC.) Cummins), *Cissus sicyoides* L. (*Endophyllum circumscriptum* Whetzel & Olive var. *catamarcensis* J.C. Lindq.), *Cucurbitella cucumifolia* (Griseb.) Cogn. (*Uromyces novissimus* Speg.), *Cupania vernalis* Cambess. (*Skierka* sp.), *Desmodium purpureum* Hook. & Arn. (*Uromyces orbicularis* Dietel), *Desmodium purpureum* Hook. & Arn. (*Uromyces castaneus* P. Syd. & Syd.), *Dichondra sericea* Sw. (*Puccinia dichondrae* Mont.), *Duchesnea indica* (Andrews) Focke (*Frommeella mexicana* var. *indicae* J.W. McCain & J.F. Hennen), *Gladiolus* sp. (*Uromyces transversalis* (Thüm.) G. Winter), *Hydrocotyle bonariensis* Comm. ex Lam. (*Puccinia hydrocotyles* Cooke), *Ichnanthus minarum* (Nees) Döll (*Puccinia* sp. B, *Puccinia inclita* Arthur, *Puccinia levis* (Sacc. & Bizz.) Magnus var. *panici-sanguinalis* (Rangel) Ramachar & Cummins), *Leptochloa mucronata* (Michaux) Kunth (*Puccinia leptochloae* Arthur), *Mikania micrantha* Kunth (*Puccinia spegazzinii* De Toni), *Pelargonium hortorum* L.H. Bailey (*Puccinia pelargonii-zonalis* Doidge), *Poiretia tetraphylla* (Prior.) Burkart (*Puccinia bergii* Speg.), *Pteris deflexa* Link (*Desmella anemiae* Syd. & P. Syd.), *Rubus boliviensis* Focke (*Gerwasia imperialis* (Speg.) J.C. Lindq., *Kuehneola loeseneriana* (Henn.) H.S. Jacks. & Holw.), *Senna birostris* var.

hookeriana (Gillies ex Hook. & Arn.) H.S. Irwin & Barneby (*Ravenelia macrocarpa* Syd. & P. Syd.), *Senna hookeriana* Batke (*Ravenelia macrocarpa* Syd. & P. Syd.), *Setaria lachnea* (Nees) Kunth (*Puccinia chaetochloae* Arthur), *Setaria parviflora* (Poir.) Kerguélen (*Puccinia chaetochloae* Arthur), *Sorghum cafrorum* (Thunb.) P. Beauv. (*Puccinia purpurea* Cooke), *Thelypteris quadrangularis* (Fée) Schelpe (*Desmella anemiae* Syd. & P. Syd.), *Thelypteris* sp. (*Desmella anemiae* Syd. & P. Syd.), *Tournefortia paniculata* Cham. (*Aecidium tournefortiae* Henn.), *Tripogandra* sp. (*Puccinia commelinae* Holw.), *Triumphetta* sp. (*Puccinia triumfettae* Dietel & Holw.), *Valeriana* sp. (*Aecidium* sp.).

New host plant species for which another rust was previously known from Argentina (AR):

Aloysia virgata (Ruiz & Pav.) Juss. (*Prospodium lippiae* (Speg.) Arthur), *Aristida* sp. (*Puccinia aristidae* Tracy var. *chaetaria* Cumm. & Husain), *Aspilia* sp. (*Uromyces aspiliae* H.S. Jacks. & Holw.), *Avena sativa* L. (*Puccinia coronata* Corda var. *rangiferina* (S. Ito) Cummins), *Baccharis* sp. (A) (*Puccinia exornata* Arthur), *Baccharis* sp. (B) (*Puccinia exornata* Arthur), *Baccharis lilloi* Heering (*Puccinia baccharidis* Dietel & Holw.), *Baccharis* sp. (*Puccinia unicolor* Arthur), *Chloris gayana* Kunth (*Puccinia cacabata* Arthur & Holw.), *Chrysanthemum* sp. (*Puccinia tanaceti* DC. var *tanaceti*), *Clytostoma callistegioides* (Cham.) Bureau ex Griseb. (*Prospodium singeri* Petr.), *Digitaria insularis* (L.) Fedde (*Puccinia oahuensis* Ellis & Everh.), *Elephantopus mollis* Kunth (*Coleosporium vernoniae* Berk. & M.A. Curtis), *Eupatorium macrocephalum* Less. (*Puccinia conoclinii* Seym. in Burrill), *Eupatorium* sp. (*Cionothrix praelonga* (G. Winter) Arthur), *Hyptis mutabilis* (Rich.) Briq. (*Puccinia hyptidis-mutabilis* Mayor), *Hyptis* sp. (*Puccinia hyptidis-mutabilis* Mayor), *Inga edulis* Mart. (*Ypsilospora* sp.), *Panicum* sp. (*Puccinia levis* (Sacc.& Bizz.) Magnus var. *panici-sanguinalis* (Rangel) Ramachar & Cummins), *Paspalum* sp. (*Physopella compressa* (Mains) Cummins & Ramachar), *Pluchea* sp. (*Puccinia ocellifera* Cummins), *Pteris* sp. (*Desmella anemiae* Syd. & P. Syd.), *Salix babylonica* L. (*Melampsora epitea* (Kunze & J.C. Schmidt) Thüm.), *Salix caprea* L. (*Melampsora epitea* (Kunze & J.C. Schmidt) Thüm.), *Salix humboldtiana* Willd. (*Melampsora epitea* (Kunze & J.C. Schmidt) Thüm.), *Setaria* sp. (*Puccinia chaetochloae* Arthur), *Tradescantia* sp. (*Puccinia commelinae* Holw.).

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ADDITIONS TO THE CYPERACEAE AND JUNCACEAE FLORA OF THE RÍO MAYO REGION, SONORA, MEXICO

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ABSTRACT

Intensive floristic surveys of the Río Mayo region of the Mexican state of Sonora, particularly the Municipio de Yécora, have uncovered more species of Cyperaceae not previously reported from the region, the state of Sonora, or, in some cases, northern Mexico. Here we present 14 species of Cyperaceae and two species of Juncaceae not previously known to occur in the Río Mayo region, clarify the presence of three varieties of one *Cyperus* (Cyperaceae) species, and discuss the significance of the range extension involved with each new discovery. This brings the total number of Cyperaceae taxa known from the Río Mayo region to 99 and Juncaceae taxa to 14.

RESUMEN

Las herborizaciones florísticas intensivas en la región de Río Mayo en el estado Mexicano de Sonora, particularmente en el Municipio de Yécora, han descubierto más especies de Cyperaceae que no habían sido citadas previamente de esta región, del estado de Sonora, o, en algunos casos, el norte de México. Presentamos quí 14 especies de Cyperaceae y dos especies de Juncaceae que no se conocían previamente de la región de Río Mayo, clarificamos la presencia de tres variedades y una especie de *Cyperus* (Cyperaceae), y se discute el significado del rango de extensión implicado en cada descubrimiento. Esto lleva el número total de táxones conocidos de Cyperaceae de la región Río Mayo a 99 y el taxones de Juncaceae a 14.

Gentry's 1942 Río Mayo Plants was a major contribution to the knowledge of the flora and vegetation of northwestern Mexico. The Río Mayo region includes the area in southern Sonora and adjacent Chihuahua between the Río Fuerte and Río Yaqui drainages. Beginning in the 1970s, a new network of roads, especially Mexico Federal Highway 16 (MEX 16) between Hermosillo, Sonora, and La Junta, Chihuahua, was completed in 1992 and provided access to many areas of the Sierra Madre Occidental not previously explored floristically (Búrquez et al. 1992). A revision of the Río Mayo flora (Martin et al. 1998) incorporated recent floras from the Cascada de Basaseachi (Spellenberg et al. 1996) and Nabogame (Laferriére 1994), Chihuahua. The total of 2825 taxa reported for the Río Mayo region included 11 genera and 77 species of Cyperaceae and two genera and 12 species of Juncaceae.

An intensive floristic survey of the Municipio de Yécora, an area of 3,300 km^2 along MEX 16 in the Sierra Madre Occidental in eastern Sonora, was begun in 1995 (Reina et al. 1999; Van Devender et al. in press). The current total for the Municipio is 1648 taxa, raising the total for the Río Mayo region to over 3000

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taxa. The families with the most taxa in the Municipio de Yécora flora are Compositae (248 taxa), Gramineae (186 taxa), Leguminosae (168 taxa), Cyperaceae (59 taxa), and Euphorbiaceae (56 taxa). The genus *Cyperus* with 29 species is especially diverse. This ongoing floristic work in the Río Mayo region has uncovered more species of Cyperaceae not previously reported from the region, the state of Sonora, or, in some cases, northern Mexico. Here we present 14 species of Cyperaceae and two species of Juncaceae not previously known to occur in the Río Mayo region, clarify the presence of three varieties of one *Cyperus* (Cyperaceae) species, and discuss the significance of the range extension involved with each new discovery. Specimens were determined by Eric H. Roalson, unless noted otherwise. Most of the noteworthy records are in ciénegas or other moist areas from 1200 to 2100 m elevation in oak woodland and pine-oak forest in the Municipio de Yécora, or the grasslands and mudflow barrens within them (Reina G. et al. 1999).

Bulbostylis barbata (Rottb.) C.B.Clarke

This species is previously known from the southeast United States, Martinique, Guatemala, and the Old World tropics (Kral 1971). *Bulbostylis barbata* appears to be quite weedy and expanding its range in North America (Kral 1971). This is the first report of the species in Mexico.

Voucher specimens. **MÉXICO. Sonora. Municipio de Yécora:** 14.7 km E of Maycoba, 7.7 km E of El Kípor on MEX 16 (KM 342), pine-oak forest, 28°26'04"N 108°33'36"W, 1460 m elevation, locally common herb in soil pocket in bare area within forest, 15 Sep 1999, *Van Devender 99-647* (WS), with A.L. Reina G.

Bulbostylis pubescens (J. & C.Presl) Svenson

This species is widespread in the lowlands to the south along the Pacific slope of the Sierra Madre including the Mexican states of Sinaloa, Nayarit, Jalisco, Guerrero, Mexico, Oaxaca, and Chiapas, and south through Central America and northern South America (Kral 1971; McVaugh 1993). This is the first report of the species from the Río Mayo region and the state of Sonora.

Voucher specimens. **MÉXICO. Sonora. Municipio de Yécora:** NW of the cemetery in Yécora, spare oak woodland on barren volcanic hilltops, 28°22'40"N 108°56'W, 1540 m elevation, locally common on moist rock surfaces, 23 Sep 1997, *Reina G. 97-1172* (ARIZ, CAS, MEXU, NY, WS), with T.R. Van Devender and W. Trauba; 1.9 km SSW of Las Víboras on MEX 16 on road to Trigo Moreno, bare mudstone area in open pine-oak forest, 28°21'50"N 108°49'34"W, 1620 m elevation, locally common annual, 17 Aug 1998, *Van Devender 98-992* (ARIZ, WS), with A.L. Reina G., M.E. Fishbein, and G.M. Ferguson; tributary of Arroyo Los Pilares near bridge, 24.7 km W of Maycoba on MEX 16, oak woodland with scattered pines in shady, narrow, steep canyon, 28°23'40"N 108°47'35"W, 1300 m elevation, locally common annual in moist depressions on bare surfaces, 13 Sep 1999, *Reina G. 99-515* (WS), with T.R. Van Devender.

Carex planostachys Kunze

This species is previously known from Texas to Guatemala, and in Mexico, it is known from as far northwest as Chihuahua (Hermann 1974). This is the first report of this species in Sonora and the Río Mayo region.

Voucher specimens. **MÉXICO. Sonora. Municipio de Yécora:** 5.2 km W of Yécora on MEX 16, pine-oak forest, 28°21'48"N 108°59'12"W, 1720 m elevation, 11 Mar 1996, *Van Devender 96-87* (ARIZ, MEXU, RSA), with A.L. Reina G., S.L. Friedman, and W. Trauba, determined by Merriam C. Fritts.

Carex thurberi Dewey

This species is known from Arizona and localities across Mexico (Sonora, Chihuahua, Jalisco, Veracruz, and Chiapas), as well as Guatemala (Hermann 1974; although see McVaugh 1993; Espejo & López F. 1997). This is the first report of this species for the Río Mayo region.

Voucher specimen. **MÉXICO. Sonora. Municipio de Yécora:** ca. 2 km (by air) W of Yécora, pine-oak forest, 28°22'15"N 108°57'30"W, 1580 m elevation, uncommon herbaceous perennial in moist soil, 21 Jul 1998, *Trauba 425-98* (WS).

Cyperus arsenei O'Neil & Ben.Ayers

This species is previously known from the western Mexican states of Baja California Sur, Nayarit, and Michoacán and the Districto Federal (Tucker 1994). This is the first record of this species in the state of Sonora and the Río Mayo region.

Voucher specimens. **MÉXICO. Sonora. Municipio de Yécora:** 1 km W of Yécora on volcanic ridges/outcrops, W of cemetery, E facing slope with occasional *Arctostaphylos*, *Bouteloua*, other *Cyperus* sp., *Hackelochloa*, *Juniperus*, *Muhlenbergia*, occasional *Pinus*, *Quercus*, *Schizachyrium*, *Scleria*, and *Tradescantia*, 28°22'12"N 108°56'23"W, ca. 1600 m elevation, 5 Sep 1996, *Roalson 1364* (WS).

Cyperus manimae HBK

In Gentry's Río Mayo Plants (Martin et al. 1998), varieties of *C. manimae* were not distinguished. Tucker (1994) recognized three varieties of *C. manimae*, with only one of these (*C. manimae* var. *asperrimus*) known from Sonora. *Cyperus manimae* var. *divergens* is known from Chihuahua and Coahuila south to Chiapas in Mexico and south to Costa Rica and *C. manimae* var. *manimae* is known from Baja California, Sonora, and Durango to Chiapas in Mexico, south to Guatemala and northern South America (Tucker 1994; Espejo & López F. 1997). All three varieties are present in the Río Mayo region. This increases the range of var. *asperrimus* and var. *manimae* into the Río Mayo region, and the range of var. *divergens* west from Chihuahua into Sonora.

var. **asperrimus** (Liebm.) Kük.

Voucher specimens. **MÉXICO. Sonora. Municipio de Yécora:** Río Yepachic near junction with Arroyo Hondo, ca. 2 km (by air) W of Chihuahua border, oak woodland with canyon riparian forest with *Acer*, *Alnus*, *Cupressus*, and *Prunus gentryi*, 28°27'10"N 108°32'15"W, 1380 m elevation, locally common perennial on shady slope, 27 Sep 1998, *Van Devender 98-1783* (WS), with A.L. Reina G.

var. **divergens** (HBK) Kük.

Voucher specimens. **MÉXICO. Sonora. Municipio de Yécora:** Cañada La Ventana (Arroyo El Otro Lado), 2.5 km (by air) ESE of Yécora, rocky stream canyon in pine-oak forest, 28°21'38"N 108°53'55"W, 1520 m elevation, solitary perennial on rocky slope, 18 Sep 1998, *Van Devender 98 1340* (WS), with A.L. Reina G. and W. Trauba; near Rancho El Pedregoso, 15.6 km N of Yécora on road to Agua Blanca, oak woodland with grassland, 26°30'04"N 108°55'38"W, 1460 m elevation, locally common perennial in mud at edge of pond, 24 Sep 1998, *Van Devender 98-1659* (WS), with A.L. Reina G. and W. Trauba.

var. **manimae**

Voucher specimens. **MÉXICO. Sonora. Municipio de Yécora:** Pueblo Viejo on Río Mayo in Navojoa, 27°06'N 109°25'40"W, ca. 35 m elevation, locally common herbaceous perennial, 2 Oct 1995, *Van Devender 95-1127* (ARIZ, WS), with A.L. Reina G.; 2 km E of Yécora, northeast of Las Cabañas Los Champinoñes, disturbed pine-oak forest, 28°22'51"N 108°54'53"W, 1600 m elevation, common 60 cm tall herbaceous perennial in moist places, 3 Oct 1996, *Flores M. 4969* (USON, WS), with J. Sánchez; ca. 2 km NW of Yécora on old road to Santa Rosa, 28°22'33"N 108°56'24"W, 1560 m elevation, uncommon perennial in moist soil, 17 Aug 1998, *Van Devender 98-1009* (EIU, WS), with A.L. Reina G., M.E. Fishbein, and G.M. Ferguson; Cañada La Ventana (Arroyo El Otro Lado), 2.5 km (by air) ESE of Yécora, rocky stream canyon in pine-oak forest, 28°21'38"N 108°53'55"W, 1520 m elevation, uncommon perennial on rocky slope, 18 Sep 1998, *Van Devender 98-1342* (WS), with A.L. Reina G. and W. Trauba; Río Maycoba at MEX 16 (20.5 km W of Maycoba, 28.6 km E of Yécora), 28°22'15"N 108°45'30"W, 1220 m elevation, rare sedge at base of cliff, 26 Sep 1998, *Reina G. 98-1711* (WS), with T.R. Van Devender; road to Río Yepachic from MEX 16 near Arroyo Hondo (11.5 km E of El Kípor on MEX 16), oak woodland, 28°26'50"N 108°32'20"W, 1480 m elevation, very common on disturbed roadside, 27 Sep 1998, *Van Devender 98-1808* (WS), with A.L. Reina G.

Cyperus sphaerolepis Boeck.

This species is known from New Mexico, Arizona, and west Texas south to Puebla and the Districto Federal in Mexico, and has been documented previously from Sonora (McVaugh 1993; Tucker 1994; Espejo & López F. 1997). This species was not listed, however, for the Río Mayo region (Martin et al. 1998). These specimens verify its presence there.

Voucher specimens. **MÉXICO. Sonora. Municipio de Yécora:** 1 km W of Yécora on mudflow ridges/outcrops, W of cemetery, E facing slope with occasional *Arctostaphylos*, *Bouteloua*, other *Cyperus* sp., *Hackelochloa*, *Juniperus*, *Muhlenbergia*, occasional *Pinus*, *Quercus*, *Schizachyrium*, *Scleria*, and *Tradescantia*, 28°22'12"N 108°56'23"W, ca. 1600 m elevation, 5 Sep 1996, *Roalson 1360*, *1362*, and *1363* (all WS); NW of the cemetery in Yécora, sparse oak woodland on barren mudflow hilltops, 28°22'40"N 108°56'W, 1540 m elevation, uncommon sedge in wet area on bare mudflow hilltop, 23 Sep 1997, *Reina G. 97-1162* (WS) and *97-1183* (ARIZ, MEXU, WS), with T.R. Van Devender and W. Trauba; Ciénega de Camilo, 6.3 km E of El Kípor, 11.2 km W of Chihuahua border on MEX 16, sphagnum bog in clearing in shady riparian pine-oak forest, 28°46'43"N 108°31'50"W, 1580 m elevation, solitary in marsh, 25 Sep 1997, *Reina G. 97-1412* (WS), with T.R. Van Devender (Van Devender et al. in press); El Encinal, ca. 3.5 km E of Maycoba, 28°24'07"N 108°37'W, 1600 m elevation, locally common perennial in moist soil in open oak woodland, 20 Nov 1997, *Van Devender 97-1538* (ARIZ, WS), with A.L. Reina G., A.M. Rea, C. Cassa, and A.E. Gondor.

Eleocharis macrostachya Britton

This is a widespread species known from much of the United States, southwestern Canada, and north-central Mexico. In Mexico it is previously known from Chihuahua, Durango, Aguascalientes, Jalisco, Michoacán, Mexico, Querétaro, the Districto Federal, Oaxaca, Puebla, Hidalgo, and San Luis Potosí (McVaugh 1993). This is the first report for its presence in the Río Mayo region and the first report for Sonora.

Voucher specimen. **MÉXICO. Sonora. Municipio de Yécora:** Yécora, freshwater marsh, 28°22'02"N 108°55'47"W, 1505 m elevation, occasional herbaceous perennial in marsh, 16 Jul 1997, *Van Devender 97-816* (ARIZ, MEXU, USON, WS), with A.L. Reina G., D. Larson, P. Merlin, M.J. Martínez C., G. Fergu-

son, M. Kaib, and R.L. Bellsey; below El Llano on Mesa del Campanero (W of Yécora), 28°20'30"N 109°01'55"W, 2100 m elevation, locally common sedge in moist soil around well, 1 Jun 1999, *Reina G. 99-176* (WS), with T.R. Van Devender, K. Baker, P. West, and R. Scarborough.

Eleocharis svensoniana S.González E.

This species was described in 1985 from the state of Durango, Mexico (González E. 1985) and is also known from the states of Jalisco (McVaugh 1993) and Sinaloa (Espejo & López F. 1997). These collections represent the first record of this species in the Río Mayo region and Sonora and are a significant northward expansion of the species distribution from Durango and Sinaloa.

Voucher specimen. **MÉXICO. Sonora. Municipio de Yécora:** NW of the cemetery in Yécora, sparse oak woodland on barren volcanic hilltops, 28°22'40"N 108°56'W, 1540 m elevation, uncommon on moist rock surfaces, 23 Sep 1997, *Reina G. 97-1171* (WS), with T.R. Van Devender and W. Trauba; Ciénega de Camilo, 6.3 km E of El Kípor, 11.2 km W of Chihuahua border on MEX 16, sphagnum bog in clearing in shady riparian pine-oak forest, 28°46'43"N 108°31'50"W, 1520 m elevation, abundant sedge in mud at edge of ciénega, 27 Sep 1998, *Van Devender 98-1827* (WS), with A.L. Reina G. (Van Devender et al. in press).

Eleocharis yecorensis E.H.Roalson

This species was described in 1999 from material collected in a freshwater marsh on the outskirts of Yécora (Roalson 1999). It now appears that this species is quite widespread, with documented localities as far south as Nicaragua (Stevens et al. 2001).

Voucher specimens. **MÉXICO. Sonora. Municipio de Yécora:** 2.0 km S of MEX 16 at Yécora, fresh water marsh in grassland, 28°21'42"N 108°55'48"W, 1540 m elevation, 7 Sep 1996, *Reina G. 96-486* (ARIZ, WS), with T.R. Van Devender and W. Trauba; SSW side of Yécora, 28°22'09"N 108°56'04"W, ca. 1500 m elevation, 8 Sep. 1996, *Roalson 1385* (Type collection; MEXU, MICH, MO, RSA, UC, WS); Yécora, 28°22'02"N 108°55'47"W, 1,505 m, 16 Jul 1997, *Van Devender 97-810* (ARIZ, WS).

Fimbristylis complanata (Retz.) Link

This species is previously known from the New and Old World tropics (Kral 1971; McVaugh 1993), and prior to Martin et al.'s (1998) discovery of it in Chihuahua, the northernmost record of this species in the New World was from Durango. This is the first report of this species from Sonora. This species has also recently been collected by Richard S. Felger and collegues N of Guaymas, Sonora (Municipio de Guaymas, Cañón La Balandrona, N side of Sierra El Aguaje, 28°04.27'N, 111°04.44'W, 825 ft. elevation, 19 Dec 2001, *Felger 01-659* (USON, ARIZ, MEXU), with J. Sánchez E. and P.A. West; R.S. Felger, pers. comm.).

Voucher specimen. **MÉXICO. Sonora. Municipio de Yécora:** Arroyo La Cueva, 8 km N of Yécora on the road to Agua Blanca, rocky stream canyon in pine-oak forest, 28°26'27"N 108°55'29"W, 1520 m elevation, uncommon perennial in moist soil at edge of stream, 24 Sep 1998, *Van Devender 98-1633* (WS), with A.L. Reina G. and W. Trauba.

Fimbristylis decipiens Kral

This species was described by Kral in 1971 "... to represent an intermediate morphology between *F. dichotoma* and *F. annua*." It is difficult to tell *F. decipiens*

from *F. dichotoma* and *F. annua*, but the two specimens listed below seem to fall within Kral's circumscription. Kral recognized this species in the southeast United States, but suggested it was likely in Central and South America and the Old World (Kral 1971). This is the first report for Sonora and the Río Mayo region.

Voucher specimen. **MÉXICO. Sonora. Municipio de Yécora:** 2.1 km W of Arroyo Hondo, 6.1 km W ol Chihuahua border on MEX 16, open pinyon-juniper-oak woodland on steep pink and white volcanic ash, 28°26'24"N 108°33'20"W, 1400 m elevation, 25 Sep 1997, *Reina G. 97-1374* (ARIZ, MEXU, NY, WS), with T.R. Van Devender; Arroyo El Toro on NE edge of Yécora, 28°22'45"N 108°55'15"W, 1520 m elevation, locally common sedge in mud near stream, 2 Oct 1998, *Van Devender 98-1997* (WS), with A.L. Reina G.

Fimbristylis pentastachya Boeck.

This species has been traditionally known from southern Mexico (Kral 1971). McVaugh (1993) listed *F. pentastachya* from southern Sonora and Martin et al. (1998) listed it for the Río Mayo region in Chihuahua. This collection expands its range into the Sonoran portion of the Río Mayo region.

Voucher specimen. **MÉXICO. Sonora. Municipio de Yécora:** 1.0 km SSW of Las Víboras on MEX 16 on road to Trigo Moreno, bare mudstone area in open pine-oak forest, 28°22'18"N 108°49'42"W, 1620 m elevation, uncommon herbaceous perennial in moist soil, 17 Aug 1998, *Van Devender 98-998* (WS), with A.L. Reina G., M.E. Fishbein, and G.M. Ferguson.

Lipocarpha maculata (Michx.) Torr.

This species is previously known from the southeastern United States, in Mexico the states of Nayarit, Jalisco, Veracruz, and Chiapas, Central and South America, and the West Indies, although this species is thought to be uncommon in Mexico (McVaugh 1993). This is the first report of this species from the Río Mayo region and the state of Sonora, with the closest documented locality to the south in Jalisco and Nayarit (Espejo & López F. 1997).

Voucher specimen. **MÉXICO. Sonora. Municipio de Yécora:** SSW side of Yécora, 28°22'09"N 108°56'04"W, approximately 1500 m elevation, 8 Sep. 1996, *Roalson 1389* (WS); Cañada La Ventana (Arroyo El Otro Lado), 2.5 km (by air) ESE of Yécora, rocky stream canyon in pine-oak forest, 28°21'38"N 108°53'55"W, 1520 m elevation, locally abundant dwarf sedge on shallow soil on mud flow slope, 1 Oct 1998, *Reina G. 98-1967* (ARIZ, WS), with T.R. Van Devender and W. Trauba.

Scleria interrupta Rich.

Two collections from the Río Mayo region apparently fall within the circumscription of *Scleria interrupta* (Konraed Camelbeke, pers. comm.). This is an extreme range extension with the closest localities of this species in Chiapas (Espejo & López F. 1997). The two collections vary somewhat in the characteristics of pubescence and extent of the tubercles on the achene. *Reina G. 97-1373* has achenes with a large number of tubercles covering the surface which at times approach a reticulate pattern and most of the bracts subtending the spikes are covered in bristly hairs on the margins and midrib. This appears to fit well within the circumscription of *S. interrupta*, somewhat tending towards the sometimes-segregate *S. pinetorum* Britton which is included in synonymy of *S.*

interrupta here (Core 1936; Raynal 1976; Konraed Camelbeke, pers. comm.). The other collection, *Reina G. 97-1174*, includes plants with achenes that are mostly smooth with a few tubercles at the achene apex and the bracts subtending the spikes are often near glabrous with few, scattered, bristly hairs. These plants do not fit as well in the circumscription of *S. interrupta*, and approach *S. verticillata* Muhl. (due to the lack of bristly hairs), or maybe *S. distans* Poir. (due to the smooth achenes; Core 1936). For now these two collections are treated as *S. interrupta*, but more detailed studies of the variation in achene ornamentation and pubescence in these annual *Scleria* species is necessary.

Voucher specimens. **MÉXICO. Sonora. Municipio de Yécora:** NW of the cemetery in Yécora, spare oak woodland on barren volcanic hilltops, 28°22'40"N 108°56'W, 1540 m elevation, locally common on moist rock surface, 23 Sep 1997, *Reina G. 97-1174* (ARIZ, NY, WS), with T.R. Van Devender and W. Trauba; 2.1 km W of Arroyo Hondo, 6.1 km W of Chihuahua border on MEX 16, open pinyon-juniper-oak woodland on steep pink and white mottled volcanic ash, 28°26'24"N 108°33'20"W, 1400 m elevation, locally common in moist soil depression on rocky slope, 25 Sep 1997, *Reina G. 97-1373* (WS), with T.R. Van Devender.

Juncus dichotomus Elliott

This species is quite widespread, occurring from Alaska, across the United States, Mexico, Central America, and South America (Balslev 1996; Espejo & López F. 1996; Brooks & Clemants 2000). This is the first report of *J. dichotomus* for the Río Mayo region.

Voucher specimens. **MÉXICO. Sonora. Municipio de Yécora:** El Divisidero (El Bordo), 1 km SE of El Llano on road to Bermudez, Mesa del Campanero, pine-oak forest, 28°16'48"N 109°02'31"W, 1800 m elevation, common rush in moist soil, 26 May 1996, *Reina G. 96-244* (ARIZ, MEXU, NY, WS), with T.R. Van Devender, A. Búrquez M., and L. Varela; Mesa del Campanero, Arroyo Largo, upper tributary or Barranca El Salto, pine-oak forest, 28°21'18"N 109°01'48"W, 2000 m elevation, locally common, 14 Jul 1997, *Van Devender 97-698* (ARIZ, WS), with A.L. Reina G., P. Merlin, A. Búrquez M., G. Ferguson, D. Larson, M. Kaib, and M.J. Martínez C.; Arroyo Hondo, 11.5 km E of El Kípor, 4 km W of Chihuahua border on MEX 16, pine-oak forest, 28°26'30"N 108°32'30"W, 1460 m elevation, locally common herbaceous perennial in water in rocks, 25 Sep 1997, *Reina G. 97 1392* (WS), with T.R. Van Devender; 2.3 km above Restaurant Puerto de la Cruz on road to microwave tower, Mesa del Campanero, pine-oak forest, 28°22'18"N 109°01'54"W, ca. 2150 m elevation, uncommon herbaceous perennial on moist roadside, 16 Aug 1998, *Reina G. 98-939* (WS), with T.R. Van Devender, M.E. Fishbein, R. Spellenberg, and G.M. Ferguson; Cañada La Ventana (Arroyo El Otro Lado), 2.5 km (by air) ESE of Yécora, rocky stream canyon in pine-oak forest, 28°21'38"N 108°53'55"W, 1520 m elevation, solitary clump in moist soil in narrow side canyon, 18 Sep 1998, *Van Devender 98-1303* (ARIZ, WS), with A.L. Reina G. and W. Trauba; Ciénega de Camilo, 6.3 km E of El Kípor, 11.2 km W of Chihuahua border on MEX 16, sphagnum bog in clearing in shady riparian pine-oak forest, 28°46'43"N 108°31'50"W, 1520 m elevation, solitary rush in moist soil, 27 Sep 1998, *Van Devender 98 1850* (WS), with A.L. Reina G. (Van Devender et al. in press).

Juncus liebmanii J.F.Macbr. var. **polycephalus** Balslev

This species is known from Chihuahua in Mexico south to Ecuador. The northern Mexican collections are considered part of *J. liebmanii* var. *liebmanii* or var. *polycephalus* Balslev (Balslev 1996). The Sonoran collection belongs to var. *polycephalus*. This is the first report of this species for Sonora and the Río Mayo region.

Voucher specimens. **MÉXICO. Sonora. Municipio de Yécora:** Arroyo La Cueva, 8 km N of Yécora on the road to Agua Blanca, rocky stream canyon in pine-oak forest, 28°26'27"N 108°55'29"W, 1520 m elevation, uncommon perennial in moist soil at edge of stream, 24 Sep 1998, *Van Devender 98-1634* (WS), with A.L. Reina G. and W. Trauba.

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Frederick R. Gehlback. 2002. **Messages from the Wild: An Almanac of Suburban Natural and Unnatural History.** (ISBN 0-292-72837-9, hbk.; 0-292-72838-7, pbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, 800-252-3206, 800-687-6046 fax). $45.00 (hbk), $24.95 (pbk), 280 pp., 24 color photos, 12 line drawings, 5 1/2" × 9".

Key Words: Natural history, Texas, central Texas, environmental studies, animals, migrations of birds, plants, ecology, life cycles.

Alfred Richardson. 2002. **Wildflowers and Other Plants of Texas Beaches and Islands.** (ISBN 0-292-77115-0, hbk.; 0-292-7716-9, pbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (Orders: 800-252-3206 fax; 512-471-4032). $65.00 (hbk), $29.95 (pbk), 271 pp., 316 color photos, 1 map, 5 3/4" × 8 1/4".

Key Words: Texas, beaches, natural history, field guides, wildflowers, identification, botany, descriptions.

You'll wish you had this book the next time you visit Padre Island for any reason. Richardson provides an interesting guide to some 275 common and/or noteworthy flowering plants from the Rio Grande to Louisiana.

Raymond C. Telfair II (ed.). 1999. **Texas Wildlife Resources and Land Uses.** (ISBN 0-292-78159-8, pbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (Orders: 800-252-3206 fax; 512-471-4032). $26.95, 416 pp., 20 b/w photos, 39 tables, 6" × 9".

Key Words: Texas, wildlife resources, land uses, environmental history, conservation, agricultural development and sustainability, water resources, ecological regions, plants, animals.

If you need information at your fingertips on Texas Parks, National Parks, National Wildlife Refuges, or National Forests and Grasslands, then you should have this book on your library shelf. The handy book is divided into five major sections: **Part 1)** Perspectives on Texas Wildlife Resources; **Part 2)** Future Expectations in Land Use; **Part 3)** The Public and Future Demands for Wildlife; **Part 4)** Wildlife Management and Research; and **Part 5)** Wildlife Management on Public Lands. Four great appendices are provided: **1)** Conservation Organizations in Texas; **2)** Plants Cited in the text; **3)** Animals Cited in the Text; and **4)** Texas Threatened and Endangered Species, November 1997.

LISTADO PRELIMINAR DE LAS CACTÁCEAS Y AGAVACEAS DE LA SIERRA "EL VIEJO," SONORA, REGIÓN PRIORITARIA PARA LA CONSERVACIÓN EN MÉXICO

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RESUMEN

La Sierra "El Viejo" se ubica en el municipio de Pitiquito y Caborca, Sonora, en la porción Centro - Oeste del desierto sonorense. El complejo orográfico Sierra "El Álamo"–Sierra "El Viejo" está catalogado como una Región Prioritaria Terrestre para la conservación en México. Este trabajo tiene por objetivo contribuir al conocimiento florístico de las familias Cactaceae y Agavaceae principalmente en la Sierra "El Viejo." Se hizo una revisión bibliográfica para establecer las especies que, posiblemente, se encontrarían en el área y posteriormente se corroboraron en campo mediante recorridos en diversas localidades. Se registraron 21 especies de cactáceas distribuidas en 10 géneros y 4 especies de Agavaceas en 2 géneros, lo que hace un total de 25 especies distribuidas en las dos familias. Las especies de Cactáceas representan un 21 % del total de las especies presentes en el estado de Sonora. Una especie, *Ferocactus cylindraceus*, cuenta con categoría de protección. La literatura señala que dos de las especies de agaves son endémicas a la Sierra "El Viejo," *Agave pelona* y *A. zebra*. Se sugiere continuar con estudios para la determinación de variedades y formas taxonómicas, así como también estudios ecológicos en algunas especies, para establecer programas de manejo y protección de las poblaciones y el área en conjunto.

ABSTRACT

Sierra "El Viejo" is located in the municipality of Pitiquito and Caborca, Sonora, in the west central portion of the Sonoran Desert; the complex Sierra "El Álamo"–Sierra "El Viejo" is catalogued as a terrestrial high-priority region for nature conservation in Mexico. The objective for this study is to contribute to the floristic knowledge of the families Cactaceae and Agavaceae within this region, mainly in the Sierra "El Viejo." Bibliographical research was carried out and species reported were corroborated in the field by searching different localities in the area. Twenty-one species of cacti, in 10 genera, and 4 species, and 2 genera of the Agavaceae family were recorded. A total of 25 species are recorded in the two families. The total of species in the Cactus family represents 21 % of the total species present in the state of Sonora. One species of cactus is protected by federal law, *Ferocactus cylindraceus*. Two species of agaves, *Agave pelona* and *A. zebra* are endemic to the region. Further floristic and ecological work is needed in the region that will support conservation, management and protection of the natural resources of this particular region.

INTRODUCCIÓN

Importancia

Las familias Cactaceae y Agavaceae cuentan con diversos estudios taxonómicos y de distribución en algunos estados y municipios de la república mexicana. No obstante existen estados en donde se tiene un pobre conocimiento en estas

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familias en lo que a taxonomía y distribución se refiere. Dada la importancia que estas familias tienen en el ámbito comercial (como plantas de ornato altamente cotizadas, medicinales y de alimento), es necesario promover estudios de estos grupos taxonómicos.

La sierra "El Viejo" está catalogada como una región terrestre prioritaria para la conservación en México (Arriaga et al. 2000; RPT Clave 16). Bajo este criterio, consideramos que para la región, existe un conocimiento de escaso a regular en cuanto a inventarios de especies, por lo que el desarrollo de listados florísticos y faunísticos es de suma importancia para la correcta planeación en acciones de conservación y manejo del área. De igual forma, el mismo autor, considera que la región se encuentra en un excelente estado de conservación y con una alta integridad ecológica, lo que permite una buena oportunidad para llevar con éxito planes de conservación y de manejo.

Objetivos

1) Ampliar el conocimiento florístico y de distribución para las especies de la familia Cactaceae y Agavaceae en la Sierra "El Viejo."
2) Aportar algunos datos sobre su etnobotánica e importancia ecológica.

Área de estudio

La sierra "El Viejo" se encuentra ubicada en los municipios de Caborca y Pitiquito, Sonora, en el noroeste de la republica Mexicana (Fig. 1). Ocupa una extensión aproximada de 1,128 km^2, constituida principalmente por lomeríos y elevaciones montañosas que van desde los 200 a los 1,000 msnm. El clima es desértico o muy seco semicálido BWhw (x')(e'). El ciclo de lluvias es bianual y se presenta en verano y otoño e invierno. La vegetación de la planicie corresponde al matorral desértico micrófilo y en la sierra la vegetación corresponde al matorral micrófilo sarcocaule.

MÉTODO

Durante los meses de enero a diciembre de 1999 se realizaron recorridos por diferentes localidades de la Sierra "EL Viejo" y sus planicies aledañas. Se corroboraron los registros existentes en la literatura y la taxonomía de las diferentes especies de cactáceas que se encuentran en esta área. La identificación taxonómica se hizo siguiendo los criterios de Bravo-Hollis (1978), Bravo-Hollis y Sánchez-Mejorada (1991) y algunas modificaciones según Anderson (2001).

RESULTADOS

Se encontraron un total de 10 géneros y 21 especies para la familia Cactaceae y dos géneros con cuatro especies para la familia Agavaceae (Tabla 1 y 2). Las especies de la familia Cactaceae representan aproximadamente el 21 % del total registrado para el estado de Sonora.

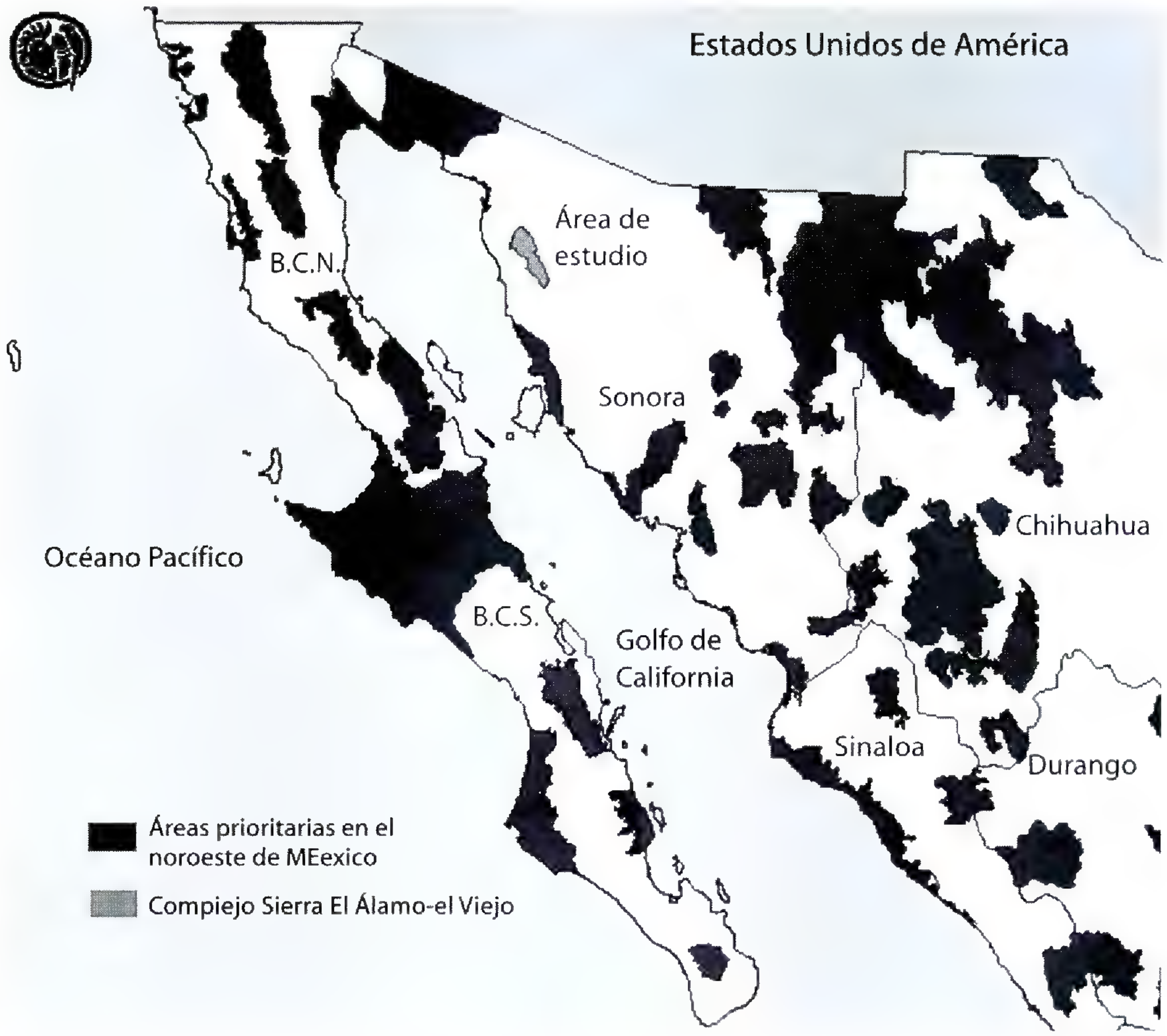


Fig. 1. Localización del área de estudio y su ubicación con respecto a otras áreas prioritarias para la conservación dentro del noroeste de México (Modificado de CONABIO, 2000)

DISCUSIONES Y CONCLUSIONES

Si bien la sierra "El Viejo" ha sido explorada por diversos investigadores (Gentry 1951, 1966; Turner 1980, 1983; Dimmitt 1983; Yatskievych y Fischer 1981 y 1982) es considera por Arraiga (2000), como un área que no ha sido revisada de una manera detallada. El conocimiento botánico en esta área podría aumentar enormemente, teniendo como ejemplo que Yatskievych y Fischer (1984) encontraron los siguientes nuevos registros de la familia Cactaceae: *Ancisirocatus uncinatus*, *Echinocactus horizontalonius*, var. *nicholii*, *Echinocereus scopulorum* y *Mammillaria lasiacantha*, de estas especies se ha podido corroborar la presencia de todas ellas excepto de *E. horizontalonius* var. *nicholii*, esta especie fue encontrada originalmente en la porción norte de la sierra, consistiendo su colecta en un solo ejemplar. Al examinar ejemplares de *Mammilaria lasiacntha*, se tiene cierta reserva al definir esta especie, debido

TABLA 1. Especies de Cactáceas en la Sierra "El Viejo."

Nombre Científico	Nombre Común
Carnegiea gigantea (Engelm.) Britton & Rose 1908	Sahuaro
Echinocereus fendleri (Engelm.) F. Seitz 1870	Cholla
Echinocereus nicholii (L.D. Benson) B.D. Parfitt 1987	Cnolla barbona
Echinocereus scopulorum Britton & Rose 1922	Cabecita de viejo
Ferocactus covillei Britton & Rose 1922	Biznaga
Ferocactus cylindraceus (Engelm.) Orcutt 1926	Biznaga
Hamatocactus uncinatus (Galeotti) Orcutt 1926	Biznaga de anzuelos
Lophocereus schottii (Engelm.) Britton & Rose 1909	Cinita, cina, tuna barbona
Mammillaria grahamii Engelm. 1856	Cabecita de viejo
Mammillaria thornberi Orcutt 1902	Cabecita de viejo
Mammillaria sp. (aff. *lashiacantha*)	Cabecita de viejo
Opuntia acanthocarpa Engelm. & Bigelow 1856	Sibiris
Opuntia arbuscula Engelm. 1856	Cholla
Opuntia bigelovii Engelm. 1856	Cholla brincadora, velas de coyote
Opuntia engelmannii Salm-Dyck ex Engelm. 1850	Nopal
Opuntia fulgida Engelm. 1856	Cholla plateada
Opuntia leptocaulis A. DC. 1828	Tasajillo o sibirito
Opuntia macrocentra Engelm. 1857	Nopal morado
Pachycereus pringlei (S. Watson) Britton & Rose 1909	Cardón o sabueso
Peniocereus striatus (T. Brandegee) Buxbaum 1975	Sacamatraca
Stenocereus thurberi (Engelm.) Buxbaum 1961	Pitahaya

TABLA 2. Especies de Agavaceas en la Sierra "El Viejo."

Nombre Científico	Nombre Común	Usos Tradicionales
Agave pelona Gentry	Lechuguilla	Extracción de fibras
Agave schotii Engelm.	Amol, amole	Usos medicinales y cosméticos
Agave zebra Gentry	Maguey	Fabricación de bebidas alcohólicas
Yucca arizonica McKelvey	Jobichi, palma	Uso alimenticio

existen diferencias en el color de la flor y la espinación, por lo cuál actualmente se encuentran en revisión para determinar su categoría taxonómica de una manera correcta.

Comparativamente, la Sierra El Viejo se puede considerar rica en especies de cactáceas, ya que Felger (1992), al realizar una sinopsis de las plantas vasculares del noroeste de Sonora, aproximadamente 15,000 km^2 (incluyendo la reserva de la biosfera "El Pinacate"), registra 10 géneros, 26 especies y 7 variedades (reconocidas por Anderson 2001). En la Sierra "El Viejo," área 13 veces menor, se señalan igual número de géneros y cinco especies menos; para la familia Agavaceae solo existen 2 géneros con una especie cada uno.

Hernández (1998) caracterizó la vegetación en el área de la Sierra "El Viejo," y registró nueve cactáceas, además de *Agave* sp. y *Yucca* sp. sin profundizar en su categoría taxonómica. El presente estudio arroja más del doble de especies de cactáceas y determina las especies de agaves mediante la revisión de literatura ya existente. Cabe destacar que dos especies (*Agave pelona* y *A. zebra*) son endémicas de la Sierra «El Viejo» y por lo menos *A. pelona* es parte importante de la dieta y fuente de agua para el borrego cimarrón (*Ovis canadensis mexicana*) que habita la región. Precisamente es con el borrego cimarrón, con quien se observó un fenómeno interesante de interacción entre fauna y flora, durante la época de floración de *A. pelona*, se da un alto consumo de los escapos florales de esta especie por parte del borrego cimarrón y a lo largo del año se consumen plantas enteras para satisfacer las necesidades tanto alimenticias como hídricas.

Cabe destacar que del total de las especies de cactáceas solo una, *Ferocactus cylindraceus*, está dentro de la norma NOM-059-ECOL-1994 (Diario Oficial de la Federación 1994), bajo la categoría de rara y que ninguna de las especies de agaváceas está en alguna categoría de dicha norma, a pesar de que dos de ellas son endémicas del área.

Históricamente y de acuerdo con los pobladores locales, se ha realizado extracción de *Agave pelona* y *A. zebra*. El primero para la extracción de fibras vegetales y el segundo para la elaboración, a pequeña escala, de una bebida alcohólica. A pesar de dicho aprovechamiento (realizado en la primera mitad del siglo XX), las poblaciones se encuentran en un buen estado, ya que se observan individuos de *Agave* de todos los tamaños y clases de edades.

La Sierra "El Viejo," área prioritaria para la conservación en México, mantiene dentro de sus límites un total de 21 especies de cactáceas distribuidas en diez géneros, siendo *Opuntia* el género (7 spp.) más diverso, seguido por *Echinocereus* y *Mammillaria* (3 spp.). Esto representa aproximadamente un 21 % del total de especies registradas para el estado de Sonora (Paredes et al. 2000). Las especies de la familia Agavaceae están representadas por el género *Agave* (3 spp.) y el genero *Yucca* (1 sp.).

AGRADECIMIENTOS

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VASCULAR FLORA OF BIG LAKE BOTTOM WILDLIFE MANAGEMENT AREA, ANDERSON COUNTY, TEXAS

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ABSTRACT

A floristic inventory of Big Lake Bottom Wildlife Management Area, a bottomland hardwood forest located on the Trinity River approximately 16 km SW of Palestine in Anderson Co., Texas, was conducted from October 1997 to July 2001. The study area is characterized by eight distinct alliances: 1) Overcup Oak Water Hickory; 2) Willow Oak; 3) Planer Tree; 4) Cottonwood; 5) Sugarberry-Cedar Elm; 6) Bur Oak-Shumard Oak; 7) Post Oak-Blackjack Oak; and 8) Sand Post Oak-Bluejack Oak. The annotated list of taxa includes 99 families, 298 genera, and 459 species.

RESUMEN

Se realizó un inventario florístico del Big Lake Bottom Wildlife Management Area, un bosque de madera dura localizado en el río Trinity unos 16 km al SW de Palestine en el Anderson Co., Texas, desde octubre de 1997 a julio de 2001. El área de estudio se caracteriza por ocho alianzas distintas: 1) Overcup Oak-Water Hickory; 2) Willow Oak; 3) Planer Tree; 4) Cottonwood; 5) Sugarberry-Cedar Elm; 6) Bur Oak-Shumard Oak; 7) Post Oak-Blackjack Oak; y 8) Sand Post Oak-Bluejack Oak. El catálogo florístico de taxa incluye 99 familias, 298 géneros, y 459 especies

INTRODUCTION

The Texas Parks and Wildlife Department began purchasing bottomland in 1991 in an effort to preserve this unique and rapidly disappearing hardwood habitat. Among the first acquisitions was the area now known as Big Lake Bottom Wildlife Management Area (BLBWMA), one of the largest remaining bottomland hardwood tracts of its type in the central Trinity River basin. The area consists of approximately 1684.8 ha that lie within the transition zone between the Pineywoods and the Post Oak Savannah vegetational areas of eastern Texas (Gould 1962), about 16 km SW of Palestine. This alluvial bottomland was formed

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by the periodic erosion and sedimentation of the river as it flowed through the region. The poorly draining soils and uniform topography produced a forest dominated by hydrophytes.

Because of its unsuitability for most agricultural pursuits, the management area has remained relatively free from outside disturbances. Two of the past major disturbances were selective harvesting of timber in the late 1930s and early 1940s and the clearing of about 65 ha for cultivation in the 1950s. Current use of the property is limited to human recreational activities. Past and present water control and agricultural practices have generally widened the Trinity River, resulting in severe erosion problems along sloughs and creeks. This erosion problem has been compounded by the use of all-terrain vehicles on the management area.

Since the management area was purchased to preserve the bottomland habitat along the Trinity River, this systematic inventory of the vascular flora is imperative for proper management. Results of the study will be used by resource managers in decisions concerning activities that might affect the plant communities and ecosystems of the area. These activities include future land purchases or trades, mineral exploration, granting of rights-of-way and easements, and public use.

Field work was conducted primarily from October 1997 to October 1999, with occasional visits made until July 2001 to search for taxa expected to occur but not previously collected. The survey included more than 50 field visits that produced 532 field collections including ferns, gymnosperms, and flowering plants. Voucher specimens are deposited in the Baylor University Herbarium (BAYLU).

DESCRIPTION OF STUDY AREA

BLBWMA is located within the humid subtropical zone. Temperatures rarely go below -12° C in winter or above 38° C in summer, with the mean temperature being near 20° C (Hatch et al. 1990). The soil of the study area is predominately composed of alluvium and fluviatile terrace deposits and a small area of carbonaceous clay, silt, and ironstone on the Recklaw Formation (University of Texas Bureau of Economic Geology-Palestine Sheet 1993). The deep clay bottomland soils are classified as part of the Kaufman-Trinity Association while the more loamy and sandy uplands belong to the Axtell-Lufkin Association (Coffee 1970). Elevation varies from 57.9–82.3 m above sea level.

Nixon and Willett (1974), in the only previous study of the site located, described 5 bottomland hardwoods types. These were described as coalitions of species and not afforded names as such. Many species were included in more than one type, apparently based upon abundance. These types actually overlapped to some extent, thus we find it advantageous to use the alliance method of community description.

The BLBWMA vegetation areas can be segregated into eight alliances (National Vegetation Classification System (NVCS) 1997) based on dominant species, landscape position, and soil water content. The location, characteristic species, and a short description of each alliance follow.

Overcup Oak (Water Hickory) Seasonally Flooded Forest Alliance

The Overcup Oak (Water Hickory) Alliance is characterized by temporary standing water during and after flood events and consists of approximately 818.3 ha. This alliance is found throughout the site on heavy clay soils (Fig. 1). Dominant trees are *Quercus lyrata*, *Carya aquatica*, *Celtis laevigata* var. *laevigata* and *Ulmus americana*. Other common woody species in this area include *Fraxinus pennsylvanica*, *Ilex decidua*, and *Crataegus viridis*. Common herbaceous species include *Iva annua*, *Xanthium strumarium*, *Justicia ovata*, *Leersia lenticularis*, *Saururus cernuus*, *Lobelia cardinalis*, *Diodia virginiana*, *Gratiola virginiana*, and *Boehmeria cylindrica*.

Willow Oak Seasonally Flooded Forest Alliance

Willow Oak Alliance consists of seasonally flooded areas and is the smallest wet bottomland feature on the area at 50.2 ha. These are depressed areas of periodic inundation in which hardwood trees dominate and form a dense canopy. This alliance is located north of the drainage channel of Big Lake into Keechie Creek, an area that has been carved out by flooding events (Fig. 1). Common tree species include *Quercus phellos*, *Q. nigra*, *Celtis laevigata* var. *laevigata*, *Carya aquatica*, *Nyssa sylvatica*, *Ilex decidua*, and *Liquidambar styraciflua*. Characteristic herbs of this forest include *Carex frankii*, *Juncus coriaceus*, and *Trachelospermum difforme*.

Planer Tree Seasonally Flooded Forest Alliance

Planer Tree Alliance comprises 85.8 ha and consists of mid-story forests in backswamps and sloughs that are produced in soils created by rapid siltation. This alliance occurs along the corridor of Cedar Creek Slough and along Keechie Creek Slough just south of where Keechie Creek joins the Trinity River, as well as in a small section of the Johnson Tract (Fig. 1). Common woody plants include *Planera aquatica*, *Gleditsia aquatica*, *Forestiera acuminata*, *Carya aquatica*, *Cephalanthus occidentalis*, *Fraxinus pennsylvanica*, *Salix nigra*, and *Berchemia scandens*. Herbaceous plants include *Saururus cernuus*, *Boehmeria cylindica*, *Sesbania drummondii*, and *S. exaltata*.

Cottonwood Temporarily Flooded Forest Alliance

Cottonwood Alliance consists of 10.9 ha of periodically flooded forests on sandy alluvium primarily on developed river fronts. It is restricted to a narrow strip adjacent to the Trinity River bank (Fig. 1). Common tree and shrub species include *Populus deltoides*, *Salix nigra*, *Acer negundo*, *Gleditsia aquatica*, *Celtis laevigata* var. *laevigata*, *Betula nigra*, *Ulmus americana*, *Morus rubra*, *Cornus*

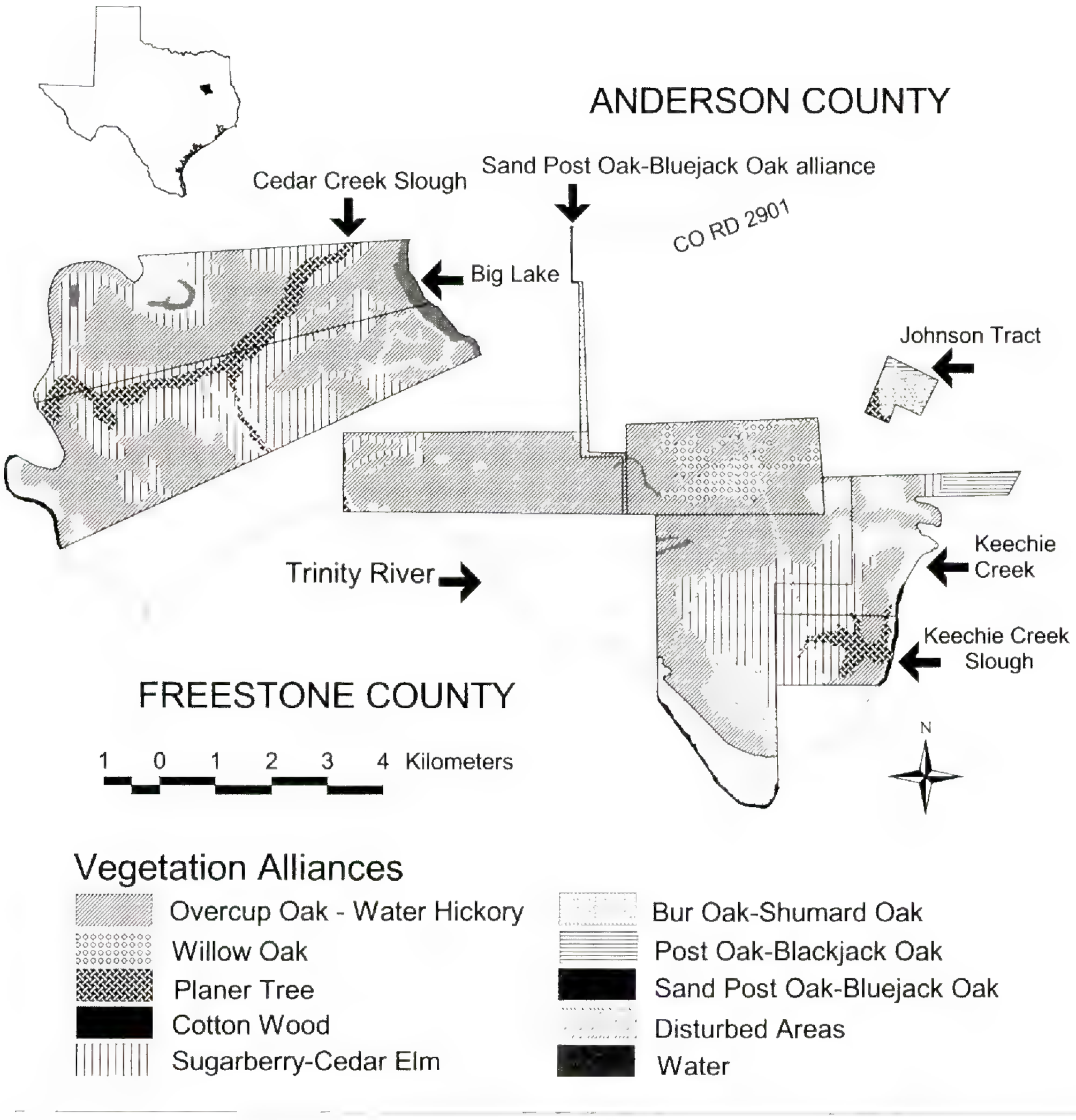


Fig. 1. A vicinity map showing Big Lake Bottom Wildlife Management Area Vegetation Alliances, Trinity River, and Big Lake (ESRI Inc. ArcView ver. 3.1).

drummondii, *Symphoricarpos orbiculatus*, and *Forestiera acuminata*. Herbaceous and woody vines are well represented. Common species include *Mikania scandens*, *Vitis riparia*, *V. palmata*, *Smilax bona-nox*, *S. tamnoides*, *Ampelopsis arborea*, *Toxicodendron radicans*, *Brunnichia ovata*, *Ipomoea cordatotriloba*, and *I. lacunosa*.

Sugarberry-Cedar Elm Temporarily Flooded Forest Alliance

Sugarberry–Cedar Elm Alliance consists of periodically flooded, forested, flat areas with rich base soils. This alliance occupies 412.4 ha along Cedar Creek Slough and along drainages of Keechie Creek (Fig. 1). Common trees include *Celtis laevigata* var. *laevigata*, *Ulmus crassifolia*, *U. alata*, *Gleditsia triacanthos*, *Sapindus saponaria* var. *drummondii*, *Quercus macrocarpa*, *Fraxinus*

pennsylvanica, *F. americana*, and *Crataegus mollis*. Herbaceous plants which typify the area include *Iva annua*, *Carex cherokeensis*, *C. crus-corvi*, *Panicum anceps*, and *Leersia oryzoides*.

Bur Oak-Shumard Oak Forest Alliance

Bur Oak-Shumard Oak Alliance occurs on bluffs and terraces with clay soils and rich humus layers. This alliance also occurs on two bluff areas that originated as a result of severe changes in river direction (Fig. 1). The area occupies 178.9 ha. This alliance was not formally described as occurring in Texas by the NVCS (1997) or as a series level community by Diamond et al. (1987) and consequently is mentioned here as occurring in Texas for the first time. Common trees and shrubs include *Quercus macrocarpa* var. *macrocarpa*, *Q. shumardii*, *Q. stellata*, *Sideroxylon lanuginosum*, *Sophora affinis*, *Juniperus virginiana*, *Crataegus viridis* var. *viridis*, *Celtis laevigata* var. *laevigata*, *Ilex decidua*, and *Cercis canadensis*. Herbaceous plants which typify the area include *Carex cherokeensis*, *Scleria triglomerata*, *Chasmanthium latifolium*, *Poa autumnalis*, *Tradescantia ohiensis*, *Arisaema dracontium*, *Podophyllum peltatum*, *Dioscorea quaternata*, *Clematis pitcheri*, *Urtica chamaedryoides*, *Stachys crenata*, *S. tenuifolia*, *Ruellia nudiflora* var. *runyonii*, *Elephantopus carolinianus*, *Matelea gonocarpos*, *Myosotis macrosperma*, *Scutellaria cardiophylla*, *Euphorbia spathulata*, *Galium circaezans*, *Oxalis violacea*, and *Parietaria pensylvanica*.

Post Oak-Blackjack Oak Woodland Alliance

Post Oak-Blackjack Oak Woodland Alliance comprises 21.5 ha and consists of upland wooded areas on gentle sandy-loam slopes and abrupt deep sand terraces. This alliance is very species rich and found on the small Johnson Tract and near entrances at each of the area gates (Fig. 1). Common trees and shrubs include *Quercus stellata*, *Q. marilandica*, *Q. incana*, *Q. falcata*, *Q. nigra*, *Q. phellos*, *Carya texana*, *Juniperus virginiana*, *Diospyros virginiana*, *Vaccinium arboreum*, *Cercis canadensis*, *Ulmus alata*, *Fraxinus americana*, *Callicarpa americana*, *Crataegus crus-galli*, *C. marshalli*, *Prunus angustifolia* var. *angustifolia*, *P. mexicana*, *P. serotina* var. *serotina*, *Rubus trivialis*, *Rhus copallina*, and *Symphoricarpos orbiculatus*. Herbaceous species include *Chasmanthium sessiliflorum*, *Elymus virginicus*, *Eragrostis secundiflora*, *Commelina erecta*, *Tradescantia hirsutiflora*, *Vitis mustangensis*, *V. rotundifolia*, *Sanicula canadensis*, *Symphyotrichum patens*, *Podophyllum peltatum*, *Hypericum hypericoides*, *Hypericum drummondii*, *Passiflora incarnata*, and *Geum canadense*.

Sand Post Oak–Bluejack Oak Woodland Alliance

This alliance occurs in deep sandy soils on a ridge above the floodplain. It consists of less than 5 ha (Fig. 1) located on the east side of Big Lake. Common tree species include *Quercus margarettiae*, *Q. marilandica*, *Q. incana*, and *Carya texana*. Other woody plants are *Opuntia stricta*, *Yucca louisianensis*, *Rhus copallina* var. *latifolia*, *Cornus florida*, *Vaccinium arboreum*, *Sassafras albidum*,

and *Prunus gracilis*. Herbaceous plants include *Tradescantia hirsutiflora*, *Matelea cynanchoides*, *Eragrotis secundiflora*, *Loeflingia squarrosa*, *Helianthemum rosmarinifolium*, *Lechea tenuifolia*, *Cnidoscolus texanus*, and *Dalea villosa*.

FLORISTICS

The BLBWMA flora includes 459 species in 298 genera in 99 families. Average number of species per genus is approximately 1.5. Families with the largest number of species (in parentheses) are Poaceae (55), Asteraceae (54), Fabaceae (32) and Cyperaceae (25). Other families with a relatively large number of species are Lamiaceae (14), Apiaceae (12), Euphorbiaceae (12), Rosaceae (12), and Scrophulariaceae (10). Genera with the most species include *Carex* (12), *Quercus* (9), *Panicum* (8), *Cyperus* (7), *Smilax* (6), and *Juncus* (5). The number of non-native species is 23, which is about five percent of the total flora.

Three plants collected on BLBWMA are considered threatened by the Texas Parks and Wildlife Department and The Nature Conservancy of Texas (Carr 2001). *Brazoria truncata* var. *pulcherrima* (*B. pulcherrima* Lundell) is considered sensitive and ranked G3 (globally) and S3 (state). Both it and *Yucca louisianensis* are also notable for being included in Estill and Cruzan's (2001) list of narrow endemics of southeastern United States. *Curcurbita texana* is also ranked G3 (globally) and S3 (state). The species was historically widely distributed along major rivers in the eastern half of Texas but much of its habitat has been lost to impoundments, agriculture, and urban development. An accurate assessment of its current status is difficult because of its ephemeral nature. *Cyperus grayoides* is ranked G3 (globally) and S3 (state).

Other noteworthy plants were new to Anderson County. Correll and Johnston (1970) report *Dioscorea quaternata* as mainly occurring in more northeastern Texas. The BLBWMA record is near the most southwestern limit of the species distribution. *Symphyotrichum eulae*, a Texas endemic, also occurs in the area. The distribution of this species is primarily in east-central Texas, where it is considered rare or uncommon. *Rhynchosia minima* var. *minima* is known from the coastal plain and northward to Newton, Houston, Travis, Bexar, Robinson, and Grimes counties. The present record is the northernmost record for the species within the state. *Heliotropium procumbens* is mostly a coastal (and western) species known to occur northward to Liberty, Waller, and Brazos counties. The new record extends the known distribution within the state farther northward. Finally, *Phyllanthus pudens* has been recorded in Texas as far north as Brazos, Madison, and Robinson counties. The Anderson County record extends the distribution farther within the state and provides a new county record.

The area contains the only known occurrence of Bur Oak-Shumard Oak Forest alliance within the state (see above).

ANNOTATED LIST OF VASCULAR PLANT TAXA BIG LAKE BOTTOM WILDLIFE MANAGEMENT AREA, ANDERSON COUNTY, TEXAS

The annotated checklist is divided into pteridophytes, gymnosperms, and flowering plants, which are subdivided into monocots and dicots. Family, genus, and species are arranged alphabetically beneath each major heading. Nomenclature follows that of Correll and Johnston (1970), Correll and Correll (1972), and Gould (1975). As needed, names were updated using Jones et al. (1997). Common names generally follow those of Hatch et al. (1990). Collector and collection numbers are given as: KF = Kay Fleming or JS = Jason Singhurst followed by a number. An asterisk (*) denotes an introduced species.

PTERIDOPHYTA

ASPLENIACEAE

Asplenium platyneuron (L.) B.S.P., Ebony spleenwort, *JS 6167.*

DRYOPTERIDACEAE

Woodsia obtusa (Spreng.) Torr., Blunt-lobed cliff fern, *JS 6166.*

MARSILEACEAE

Marsilea vestita Hook. & Grev., Hooked water clover, *KF 369.*

OPHIOGLOSSACEAE

Botrychium biternatum (Savig) Underw., Cutleaved grapefern, *KF 311.*

Botrychium dissectum Spreng., Rattlesnake fern, *KF 456.*

Ophioglossum vulgatum L., Common adder's tongue, *KF 282.*

POLYPODIACEAE

Pleopeltis polypodioides (L.) Andrews & Windham var. *michauxiana* (Weath.) Andrews & Windham, Resurrection fern, *JS 6320.*

GYMNOSPERMAE

CUPRESSACEAE

Juniperus virginiana L., Eastern red cedar, *KF 548.*

MONOCOTYLEDONEAE

AGAVACEAE

Yucca louisianensis Trel., Louisiana yucca, *KF 341.*

ALISMATACEAE

Echinodorus berteroi (Spreng.) Fassett, Beaked burweed, *KF 419.*

Echinodorus cordifolius (L.) Griseb., Heartleaf burweed, *KF 423.*

Sagittaria latifolia Willd., Duck potato, *KF 418.*

ARACEAE

Arisaema dracontium (L.) Schott, Green dragon, *JS 6693.*

ARECACEAE

Sabal minor (Jacq.) Pers., Dwarf palmetto, *KF 486.*

BROMILIACEAE

Tillandsia usneoides (L.) L., Spanish moss, *JS 6681.*

COMMELINACEAE

Commelina diffusa Burm., Spreading dayflower, *KF 633.*

Commelina erecta L., Erect dayflower, *KF 335.*

Tradescantia hirsutiflora Bush, Hairy spiderwort, *KF 265.*

Tradescantia ohiensis Raf., Ohio spiderwort, *KF 239.*

CYPERACEAE

Carex amphibola Steud., Amphibious sedge, *KF 473.*

Carex cephalophora Muhl. ex Willd., Woodbank sedge, *KF 454.*

Carex cherokeensis Schwein., Cherokee sedge, *JS 6164.*

Carex complanata Torr. & Hook., Sedge, *KF 457.*

Carex crus corvi Suttleworth ex Kunze, Crowfoot sedge, *KF 271.*

Carex flaccosperma Dewey, Thinfruit sedge, *KF 472.*

Carex frankii Kunth, Frank's sedge, *KF 452.*

Carex lurida Wahl., Shallow sedge, *KF 470.*

Carex oxylepis Torr. & Hook., Sharpscale sedge, *KF 467.*

Carex retroflexa Muhl. ex Willd., Reflexed sedge, *KF 466.*

Carex tetrastachya Scheele, Britton's sedge, *KF 461.*
Carex texensis (Torr.) Bailey, Texas sedge, *KF 286.*
Cyperus croceus Vahl, Baldwin flatsedge, *KF 451.*
Cyperus erythrorhizos Muhl., Redroot flatsedge, *KF 636.*
Cyperus grayioides Mohlenb., flatsedge, *KF 675a.*
Cyperus retrorsus Chapm., Backward flatsedge, *KF 662.*
Cyperus strigosus L. var. *strigosus*, False nutsedge, *KF 678.*
Cyperus surinamensis Rottb., Tropical flatsedge, *KF 675.*
Cyperus virens Michx. var. *virens*, Green flatgrass, *KF 386.*
Eleocharis microcarpa Torr., Smallseed spikerush, *KF 317.*
Eleocharis obtusa (Willd.) Schult., Blunt spikerush, *KF 228.*
Eleocharis palustris (L.) Roem. & Schult., Spikerush, *KF 267.*
Rhynchospora corniculata (Lam.) Gray, Horned beakrush, *KF 415.*
Scirpus pendulus Muhl., Small bulrush, JS *6174.*
Scleria triglomerata Michx., Tall nutrush, *KF 266.*

DIOSCOREACEAE

Dioscorea quaternata (Walt.) Gmel., Atlantic yam, *KF 314.*

IRIDACEAE

Iris brevicaulis Raf., Shortstem iris, *KF 1120.*
Sisyrinchium albidum Raf., White blue eyed grass, *KF 409.*
Sisyrinchium atlanticum Bicknell, Blue-eyed grass, *KF 476.*
Sisyrinchium langloisii Greene, Pale blue-eyed grass, *KF 249.*

JUNCACEAE

Juncus coriaceus Mack., Leather rush, *KF 302.*
Juncus effusus L. var. *solutus* Fern. & Weig., Common rush, *KF 305.*
Juncus marginatus Rostk. var. *setosus* Cov., Border rush, *KF 431.*
Juncus scirpoides Lam., Strong rush, *KF 407.*
Juncus tenuis Willd., Slender rush, *KF 474.*

LILIACEAE

Allium canadense L. var. *canadense*, Canada garlic, *KF 289.*
Allium drummondii Regel, Drummond's onion, *KF 275.*
Cooperia drummondii Herb., Rain lily, *KF 709.*
Hymenocallis eulae Shinners, Late spider lily, *KF 529.*
Hymenocallis liriosme (Raf.) Shinners, Spider lily, *KF 326.*
Hypoxis hirsuta (L.) Cov., Common goldstar, *KF 331.*
Nothoscordum bivalve (L.) Britt., Crow poison, *KF 224.*

ORCHIDACEAE

Spiranthes lacera (Raf.) Raf. var. *gracilis* (Bigel.) Luer., Slender ladies' tresses, *KF 212.*
Spiranthes laciniata (Small) Ames, Spring ladies' tresses, *KF 399.*

POACEAE

Agrostis hyemalis (Walt.) B.S.P., Winter bentgrass, *KF 429.*
Agrostis perennans (Walt.) Tuckerman, Autumn bentgrass, *KF 458.*
Aira elegans Willd. ex Kunth, Annual hairgrass, *KF 353.*
Alopecurus carolinianus Walt., Carolina foxtail, *KF 461.*
Andropogon ternarius Michx. var. *ternarius*, Splitbeard bluestem, *KF 653.*
Andropogon virginicus L., Broomsedge bluestem, *KF 425.*
Aristida oligantha Michx., Oldfield threeawn, *KF 624.*
Aristida purpurea Nutt., Red threeawn, *KF 625.*
Bothriochloa ischaemum (L.) Keng. var. *songarica* (Fisch. & Mey.) Celerier & Harlan, King Ranch bluestem, *KF 691.* *
Briza minor L., Little quaking grass, *KF 397.* *
Bromus secalinus L., Rye brome, *KF 380.* *
Bromus catharticus Vahl, Rescuegrass, *KF 264.* *
Buchloe dactyloides (Nutt.) Engelm., Buffalograss, *KF 390.*
Cenchrus spinifex A. Cav., Coastal sandbur, *KF 705.*
Chasmanthium latifolium (Michx.) Yates, Longleaf uniola, *KF 361.*
Chasmanthium sessiliflorum (Poir.) Yates, Sessile flowered chasmanthium, *KF 674.*
Cynodon dactylon (L.) Pers. var. *dactylon*, Bermuda grass, *KF 537.* *
Digitaria ciliaris (Retz.) Koel., Southern crabgrass, *KF 645.*
Echinochloa walteri (Pursh) Heller, Walter's barnyard grass, *KF 686.*
Elymus canadensis L., Canada wildrye, *KF 680.*
Elymus virginicus L. var. *virginicus*, Virginia wildrye, *KF 650.*

Eragrostis hypnoides (Lam.) B.S.P., Teal lovegrass, *KF 639.*
Eragrostis pectinacea (Michx.) Nees *ex* Steud., Carolina lovegrass, *KF 660.*
Eragrostis secundiflora Presl. subsp. *oxylepis* (Torr.) S. D. Koch, Red lovegrass, *KF 398.*
Eragrostis spectabilis (Pursh) Steud., Purple lovegrass, *KF 703.*
Gymnopogon ambiguus (Michx.) B.S.P., Bearded skeletongrass, *KF 651.*
Hordeum pusillum Nutt., Little barley, *KF 269.*
Leersia lenticularis Michx., Catchfly cutgrass, *KF 644.*
Leersia oryzoides (L.) Sw. var. *oryzoides*, Rice cutgrass, *KF 649.*
Leersia virginica Willd., White cutgrass, *KF 673.*
Lolium perenne L., Perennial ryegrass, *JS 6670.* *
Panicum acuminatum Sw. var. *acuminatum*, Woolly rosettegrass, *KF 316.*
Panicum nodatum Hitchc. & Chase, Sarita rosettegrass, *JS 5366.*
Panicum oligosanthes A. Shult., Rosettegrass, *KF 424.*
Panicum anceps Michx., Beaked panicum, *KF 664.*
Panicum dichotomum L., Forked panicum, *KF 659.*
Panicum hemitomon Schult., Maiden cane, *KF 619.*
Panicum ravenelii Scribn. & Merrill, Ravenel's panicum, *KF 315.*
Panicum virgatum L., Switchgrass, *KF 643.*
Paspalum dilatatum Poir., Dallisgrass, *KF 389.*
Paspalum floridanum Michx., Florida paspalum, *KF 620.*
Paspalum notatum Flugge, Bahiagrass, *KF 522.* *
Paspalum urvillei Steud., Vaseygrass, *KF 681.* *
Phalaris caroliniana Walt., Carolina canarygrass, *JS 6671.*
Piptochaetium avenaceum (L.) Parodi, Blackseed needlegrass, *KF 300.*
Poa annua L., Annual bluegrass, *KF 505.* *
Poa autumnalis Muhl. ex Ell., Autumn bluegrass, *KF 280.*
Setaria parviflora (Poir.) Kergeulen, Knotroot bristlegrass, *KF 637.*
Sorghum halepense (L.) Pers., Johnstongrass, *KF 622.* *
Tridens albescens (Vasey) Woot. & Standl., White tridens, *KF 642.*
Tridens flavus (L.) Hitchc., Purpletop, *KF 672.*
Tridens strictus (Nutt.) Nash, Longspike tridens, *KF 621.*
Tripsacum dactyloides (L.) L., Eastern gamma-grass, *KF 958.*
Triticum aestivum L., Wheat, *KF 363.* *
Vulpia octoflora (Walt.) Rydb., Common sixweeks grass, *KF 403.*

SMILACACEAE

Smilax bona-nox L., Sawtooth greenbriar, *KF 284.*
Smilax glauca Walt., Cat greenbriar, *KF 663.*
Smilax rotundifolia L., Common greenbriar, *JS 6679.*
Smilax smallii Morong, Small's greenbriar, *KF 631.*
Smilax tamnoides L., Bristly greenbriar, *KF 283.*

TYPHACEAE

Typha latifolia L., Common cattail, *KF 478.*

DICOTYLEDONEAE

ACANTHACEAE

Dicliptera brachiata (Pursh) Spreng., False mint, *KF 206.*
Justicia ovata (Walt.) Lindau var. *lanceolata* (Chapm.) Long, Lance-leaved water willow, *KF 209.*
Ruellia nudiflora (Englem. & Gray) Urban var. *runyonii* (Tharp. & Barkl.) B.L. Turner, Violet ruellia, *JS 6315.*
Ruellia pedunculata Torr. ex Gray, Low ruellia, *KF 360.*

ACERACEAE

Acer negundo L. var. *negundo*, Box elder, *KF 208.*

AMARANTHACEAE

Amaranthus albus L., White amaranth, *KF 606.*
Amaranthus blitum L., Green amaranth, *JS 6311*
Amaranthus rudis Sauer, Amaranth, *KF 607.*
Froelichia drummondii Moq., Drummond's snake cotton, *KF 542.*

ANACARDIACEAE

Rhus copallina L. var. *latifolia* H. Engler, Wing-rib sumac, *KF 276.*
Toxicodendron radicans (L.) O. Ktze. var. *radicans*, Poison ivy, *KF 310.*

APIACEAE (UMBELLIFERAE)

Chaerophyllum tainturieri Hook., Chervil, *JS 6169.*
Cyclospermum leptophyllum (Pers.) Sprague ex Britt. & P.Wils., Slimlobe celery, *KF 465.*
Cynosciadium digitatum DC., Finger dogshade, *KF 372.*
Daucus pusillus Michx., Wild carrot, *KF 381.*

Eryngium hookeri Walp., Simple leaf eryngo, *KF 487.*
Hydrocotyle verticillata Thunb., Whorled pennywort, *KF 655.*
Limnosciadium pinnatum (DC.) Math. & Const., Arkansas dogshade, *KF 400.*
Polytaenia nuttallii DC., Prairie parsley, *KF 272.*
Sanicula canadensis L., Canada sanicle, *KF 412.*
Spermolepis divaricata (Walt.) Raf. ex Ser., Forked scaleseed, *KF 355.*
Spermolepis inermis (Nutt. ex DC.) Math. & Const., Scaleseed, *KF 287.*
Trepocarpus aethusae Nutt. ex DC., Trepocarpus, *KF 460.*

APOCYNACEAE

Amsonia illustris Woods., Bluestar, *KF 247.*
Trachelospermum difforme (Walt.) Gray, Climbing dogbane, *KF 420.*

AQUIFOLIACEAE

Ilex decidua Walt., Deciduous holly, *JS 6136.*
Ilex opaca Ait. var. *opaca*, American holly, *KF 519.*
Ilex vomitoria Ait., Yaupon holly, *KF 404.*

ASCLEPIADACEAE

Asclepias amplexicaulis Smith, Bluntleaf milkweed, *KF 371.*
Asclepias tuberosa L. subsp. *interior* Woods., Butterfly milkweed, *KF 349.*
Asclepias viridis Walt., Antelopehorn milkweed, *KF 319.*
Matelea cynanchoides (Engelm.) Woods., Milkweed vine, *KF 695.*
Matelea decipiens (Alex.) Woods., Milkweed vine, *KF 667.*
Matelea gonocarpos (Walt.) Shinners, Milkweed vine, *KF 306.*

ASTERACEAE

Acmella oppositifolia (Lam.) Jansen var. *repens* (Walt.) Jansen, Creeping spot flower, *JS 6305.*
Ambrosia psilostachya DC., Western ragweed, *KF 532.*
Ambrosia trifida L., Giant ragweed, *KF 533.*
Baccharis halimifolia L., Eastern baccharis, *KF 516.*
Bidens bipinnata L. var. *biternatoides* E. Sherff, Spanish needles, *KF 608.*
Boltonia diffusa Ell. var. *diffusa*, Small head boltonia, *KF 596.*
Brickellia eupatorioides (L.) Shinners, False bonset, *KF 668.*
Chrysopsis pilosa Nutt., Soft gold aster, *KF 444.*
Cirsium horridulum Michx. var. *elliottii* T. & G., Bull thistle, *KF 327.*
Conyza canadensis (L.) Cronq., Horseweed conyza, *KF 676.*
Conoclinium coelestinum (L.) DC., Blue mist flower, *KF 205.*
Coreopsis basalis (Dietr.) Blake, Golden coreopsis, *KF 346.*
Coreopsis tinctoria Nutt. var. *tinctoria*, Plains coreopsis, *KF 433.*
Croptilon divaricatum (Nutt.) Raf., Scratch daisy, *KF 539.*
Dracopis amplexicaulis (Vahl) Cass., Dracopis, *KF 366.*
Echinacea pallida (Nutt.) Nutt., Purple cone flower, *KF 405.*
Eclipta prostrata (L.) L., Yerba de tago, *KF 594.*
Elephantopus carolinianus Raeusch., Leafy elephant foot, *KF 630.*
Erigeron tenuis T. & G., Slender fleabane, *KF 248.*
Eupatorium compositifolium Walt., Yankeeweed, *KF 623.*
Eupatorium serotinum Michx., Late eupatorium, *KF 545.*
Facelis retusa (Lam.) Sch. Bip., Facelis, *KF 301.**
Fleischmannia incarnatum (Walt.) King & Robinson, Pink eupatorium, *KF 641.*
Gamochaeta purpurea (L.) Cabrera, Greenleaf cudweed, *KF 298.*
Grindelia papposa G. Nesom & Y. Suh, saw-leaf daisy, *KF 1105.*
Helenium amarum (Raf.) H. Rock, Bitter sneezeweed, *KF 483.*
Helianthus annuus L., Common sunflower, *KF 1002.*
Helianthus debilis Nutt., Cucumber leaf sunflower, *KF 378.*
Heterotheca subaxillaris (Lam.) Britt. & Rusby, Yellow camphorweed, *KF 234.*
Hieracium gronovii L. Gronovius' hawkweed, *KF 411.*
Hymenopappus scabiosaeus L'Her., Flattop woollywhite, *KF 325.*
Iva annua L., Sumpweed, *KF 210.*
Krigia cespitosa (Raf.) Chamb., Weedy dwarf dandelion, *JS 6177.*
Lactuca floridana (L.) Gaertn., Florida wild lettuce, *KF 628.*
Liatris squarrosa (L.) Michx., Variable gayfeather, *KF 523.*

Mikania scandens (L.) Willd., Climbing hemp vine, *KF 495.*
Packera tampicana (DC.) C. Jeffrey, Golden groundsel, *KF 243.*
Pluchea camphorata (L.) DC., Camphor weed, *KF 515.*
Pluchea purpurascens (Sw.) DC., Purple camphor weed, *KF 647.*
Pyrrhopappus carolinianus (Walt.) DC., Carolina false dandelion, *KF 468.*
Rudbeckia hirta L., Late coneflower, *KF 383.*
Senecio ampullaceus Hook., Texas groundsel, *JS 6180.*
Solidago canadensis L., Tall goldenrod, *KF 632.*
Solidago petiolaris Ait., Downy goldenrod, *KF 665.*
Solidago radula Nutt., Rough goldenrod, *KF 627.*
Solidago ulmifolia Muhl. ex Willd., Noble goldenrod, *KF 658.*
Soliva pterosperma (Juss.) Less., Lawn burweed, *KF 501.*
Symphyotrichum dumosum (L.) G. Nesom, Bushy aster, *KF 213.*
Symphyotrichum eulae (Shinners) G. Nesom, Simple aster, *JS 6308.*
Symphyotrichum patens (Ait.) G. Nesom, Skydrop aster, *KF 657.*
Verbesina encelioides (Cav.) Benth. & Hook. ex Gray var. *encelioides*, Cowpen daisy, *KF 203.*
Verbesina virginica L. var. *virginica*, Frostweed, *KF 583.*
Vernonia baldwinii Torr., Baldwin's ironweed, *JS 6319.*
Vernonia texana (Gray) Small, Texas ironweed, *KF 463.*
Xanthium strumarium L., Common cocklebur, *KF 489.*

BERBERIDACEAE

Podophyllum peltatum L., May apple, *KF 39.*

BETULACEAE

Betula nigra L., River birch, *KF 540.*

BIGNONIACEAE

Campsis radicans (L.) Seeman ex Bureau, Trumpet creeper, *KF 484*

BORAGINACEAE

Heliotropium indicum L., Turnsole heliotrope, *KF 200.*
Heliotropium procumbens Mill. var. *procumbens*, Fourspike heliotrope, *KF 688.*
Myosotis macrosperma Engelm., Spring forget-me-not, *KF 296.*

BRASSICACEAE

Cardamine parviflora L. var. *arenicola* (Britt.) Schulz., Sand bittercress, *KF 463.*
Cardamine pensylvanica Muhl. ex Willd., Pennsylvania bittercress, *JS 6158.*
Lepedium virgincum L., Poor man's peppergrass, *KF 253.*
Rorippa palustris (L.) Besser, Bog bittercress, *KF 417.*
Rorippa sessiliflora (Nutt. ex T. & G.) Hitchc., Stalkless yellowcress, *JS 6304.*

BUDDLEJACEAE

Polypremum procumbens L., Juniper leaf, *KF 352.*

CACTACEAE

Opuntia stricta (Haw.) Haw., Southern spineless cactus, *KF 393.*

CALLITRICHACEAE

Callitriche heterophylla Pursh subsp. *heterophylla*, Large water starwort, *JS 6178.*

CAMPANULACEAE

Lobelia appendiculata DC. var. *appendiculata*, Earlobe lobelia, *KF 347.*
Lobelia cardinalis L., Cardinal flower, *JS 6314.*
Triodanis perfoliata (L.) Nieuw. var. *perfoliata*, Clasping Venus looking glass, *KF 320.*

CAPRIFOLIACEAE

Lonicera japonica Thunb., Japanese honeysuckle, *KF 329.* *
Lonicera sempervirens L. var. *sempervirens*, Trumpet honeysuckle, *KF 257.*
Symphoricarpos orbiculatus Moench., Coral berry, *KF 364.*
Viburnum rufidulum Raf., Rusty blackhaw, *KF 241.*

CARYOPHYLLACEAE

Arenaria serpyllifolia L. subsp. *serpyllifolia*, Thyme-leaved sandwort, *KF 502.* *
Cerastium brachypodum (Engelm. ex Gray) Robins., Shortstalk chickweed, *JS 6162.*
Cerastium glomeratum Thuillier, Clustered flower chickweed, *JS 6161.* *
Loeflingia squarrosa Nutt. subsp. *squarrosa*, Spreading loeflingia, *KF 435.*
Minuartia drummondii (Shinners) McNeill, Drummond's sandwort, *KF 244.*
Minuartia patula (Michx.) Mattf. var. *patula*, Pitcher sandwort, *KF 312.*

Silene antirrhina L., Seedy catchfly, *KF 382.*
Stellaria media (L.) Vill. subsp. *media*, Common chickweed, *JS 6160.* *

CHENOPODIACAE

Chenopodium ambrosioides L. var. *ambrosioides*, Wormseed, *KF 541.*

CISTACEAE

Helianthemum rosmarinifolium Pursh, Rosemary's rockrose, *KF 351.*
Lechea mucronata Raf., Hairy pinweed, *KF 402.*
Lechea tenuifolia Michx., Narrowleaf pinweed, *KF 410.*

CLUSIACEAE

Hypericum drummondii (Grev. & Hook.) T. & G., Drummond's St. John's wort, *KF 449.*
Hypericum hypericoides (L.) Crantz, St. Andrew's cross, *KF 242.*

CONVOLVULACEAE

Dichondra carolinensis Michx., Ponyfoot, *JS 6170.*
Ipomoea lacunosa L., Pitted morning glory, *KF 202.*
Ipomoea cordatotriloba A. Dennstaedt, Sharp pod morning glory, *KF 605.*

CORNACEAE

Cornus drummondii C. Mey., Roughleaf dogwood, *KF 256.*
Cornus florida L., Flowering dogwood, *JS 6179.*
Nyssa sylvatica Marsh., Black gum, *KF 701.*

CUCURBITACEAE

Cucumis melo L. subsp. *melo*, Muskmelon, *KF 692a.*
Cucurbita texana Gray, Texas gourd, *KF 589.*
Melothria pendula L., Drooping melonette, *KF 964.*

CUSCUTACEAE

Cuscuta pentagona Engelm., Dodder, *KF 543.*

EBENACEAE

Diospyros virginiana L., Common persimmon, *KF 464.*

ERICACEAE

Vaccinium arboreum Marsh., Farkleberry, *KF 406.*

EUPHORBIACEAE

Acalypha gracilens Gray, Slender copperleaf, *KF 661.*
Cnidoscolus texanus (Mull. Arg.) Small, Texas bull nettle, *KF 318.*
Croton capitatus Michx., Woolly croton, *KF 490.*
Croton glandulosus L., Northern croton, *KF 531.*
Croton michauxii G. Webster, Narrowleaf rushfoil, *KF 555.*
Croton monanthogynus Michx., One seed croton, *KF 635.*
Euphorbia dentata Michx., Toothed spurge, *KF 354.*
Euphorbia nutans Lag., Eyebane spurge, *KF 597.*
Euphorbia prostrata Ait., Prostrate euphorbia, *KF 690.*
Euphorbia spathulata Lam., Warty spurge, *KF 469.*
Phyllanthus pudens Wheeler, Birdseed leaf flower, *KF 685.*
Tragia brevispica Engelm. & Gray, Heartleaf noseburn, *JS 6685.*

FABACEAE

Amorpha fruticosa L., Indigo bush amorpha, *KF 441.*
Astragalus crassicarpus Nutt., Ground plum milkvetch, *KF 235.*
Baptisia nuttalliana Small, Nuttall's wild indigo, *KF 342.*
Centrosema virginianum (L.) Benth., Butterfly pea, *KF 446.*
Cercis canadensis L. var. *canadensis*, Eastern redbud, *JS 6132.*
Chamaecrista fasciculata (Michx.) Greene, Partridge pea, *KF 477.*
Clitoria mariana L., Atlantic pigeon wings, *KF 967.*
Dalea villosa (Nutt.) Spreng., Prairie clover, *KF 350.*
Desmanthus illinoensis (Michx.) MacM. ex Robins & Fern., Illinois bundle flower, *KF 615.*
Desmodium laevigatum (Nutt.) DC., Smooth beggar's ticks, *KF 217.*
Desmodium paniculatum (L.) DC., Panicled beggar's ticks, *KF 426.*
Desmodium sessilifolium DC., Sessileleaf beggar's ticks, *KF 1033.*
Galactia regularis (L.) B.S.P., Downy milkpea, *KF 656.*
Gleditsia aquatica Marsh., Water honey locust, *KF 517.*
Gleditsia triacanthos L., Common honey locust, *KF 1017.*
Glottidium vesicaria (Jacq.) R. M. Harper, Bagpod, *KF 604.*
Kummerowia striata (Thunb.) Hook. & Arn., Japanese bush clover, *KF 626.*

Lathyrus pusillus Ell., Low peavine, *KF 262.*
Lespedeza stuevei Nutt., Tall bush clover, *KF 666.*
Medicago minima (L.) L., Small bur clover, *KF 238.*
Mimosa nuttallii (DC.) B.L. Turner, Sensitive briar, *KF 332.*
Neptunia lutea (Leavenw.) Benth., Yellow neptunia, *KF 1058.*
Pediomelum digitatum (T. & G.) Isely, Palmleaf scurfpea, *KF 408.*
Rhynchosia minima (L.) DC. var. *minima*, Least snoutbean, *KF 356.*
Senna occidentalis (L.) Link, Coffee senna, *KF 1022.*
Sesbania drummondii (Rydb.) Cory, Rattlebush, *KF 526.*
Sesbania exaltata (Raf.) Rydb. ex A. Hill., Hemp sesbania, *KF 585.*
Sophora affinis T. & G., Texas sophora, *KF 309.*
Strophostyles helvula (L.) Ell., Trailing wild bean, *KF 957.*
Trifolium carolinianum Michx., Carolina clover, *KF 237.*
Trifolium vesiculosum Savi var. *vesiculosum*, Arrowleaf clover, *KF 340.* *
Vicia ludoviciana Nutt., Deer pea, *KF 291.*

FAGACEAE

Quercus falcata Michx., Southern red oak, *KF 513.*
Quercus incana Bartr., Bluejack oak, *KF 376.*
Quercus lyrata Walt., Overcup oak, *KF 507.*
Quercus macrocarpa Michx. var. *macrocarpa*, Bur oak, *KF 308.*
Quercus margarettiae Ashe ex small, Sand post oak, *KF 1115.*
Quercus nigra L., Water oak, *KF 324.*
Quercus phellos L., Willow oak, *KF 323.*
Quercus shumardii Buckl., Shumard oak, *JS 6689.*
Quercus stellata Wang., Post oak, *KF 374.*

GENTIANACEAE

Sabatia campestris Nutt., Prairie gentian, *KF 394.*

GERANIACEAE

Geranium carolinianum L. var. *carolinianum*, Carolina geranium, *KF 255.*

HALORAGRACEAE

Myriophyllum heterophyllum Michx., Changeleaf parrot's feather, *KF 432.*

HAMAMELIDACEAE

Liquidambar styraciflua L., Sweetgum, *KF 511.*

HYDROPHYLLACEAE

Hydrolea ovata Nutt. ex Choisy, Hairy hydrolea, *KF 521.*
Nama hispidum Gray, Rough nama, *KF 430.*
Nemophila phacelioides Nutt., Large flowered nemophila, *KF 288*
Phacelia hirsuta Nutt., Hairy phacelia, *KF 256.*

JUGLANDACEAE

Carya aquatica (Michx.) Nutt., Water hickory, *KF 371.*
Carya texana Buckl., Black hickory, *KF 373.*
Juglans nigra L., Black walnut, *KF 268.*

LAMIACEAE

Brazoria truncata (Benth.) Engelm. & Gray var. *pulcherrima* (Lundell) M.W. Turner, Centerville brazos mint, *KF 379.*
Hedeoma hispida Pursh, Marsh mermaidweed, *KF 396.*
Lamium amplexicaule L., Henbit, *KF 719.* *
Lycopus rubellus Moench, Water horehound, *KF 439.*
Monarda fistulosa L., Wild horsemint, *KF 480.*
Monarda punctata L., Spotted horsemint, *KF 357.*
Physostegia intermedia (Nutt.) Engelm. & Gray, Intermediate dragonhead, *KF 416.*
Physostegia virginiana (L.) Benth., Virginia dragonhead, *JS 6697.*
Salvia lyrata L., Lyreleaf sage, *KF 240.*
Scutellaria cardiophylla Engelm. & Gray, Heartleaf skullcap, *KF 436.*
Scutellaria parvula Michx., Small skullcap, *KF 279.*
Stachys crenata Raf., Shade betony, *JS 6682.*
Stachys tenuifolia Willd. subsp. *tenuifolia*, Slenderleaf betony, *KF 629.*
Teucrium canadense L., American germander, *KF 654.*

LAURACEAE

Sassafras albidum (Nutt.) Nees, Sassafras, *KF 263.*

LINACEAE

Linum sulcatum Riddell var. *sulcatum*, Grooved flax, *KF 395.*

LYTHRACEAE

Ammannia coccinea Rottb., Purple ammania, *KF 479.*
Lythrum alatum Pursh, Lanceleaf loosestrife, *KF 1086.*

MALVACEAE

Hibiscus laevis All., Scarlet rosemallow, *KF 359.*
Hibiscus moscheutos L. subsp. *lasiocarpos* (Cav.) Blach., Swamp rosemallow, *KF 359.*

Modiola caroliniana (L.) G.Don, Carolina modiola, *KF 277.*
Sida rhombifolia L., Diamond leaf mallow, *KF 618.**
Sida spinosa L., Prickly mallow, *KF 603.*

MENISPERMACEAE

Cocculus carolinus (L.) DC., Carolina snailseed, *JS 6684.*

MOLLUGINACEAE

Mollugo verticillata L., Thread carpetweed, *KF 652.*

MORACEAE

Maclura pomifera (Raf.) Schneid., Osage orange, *KF 510.*
Morus rubra L., Red mulberry, *KF 370.*

MYRICACEAE

Myrica cerifera L., Southern waxmyrtle, *KF 258.*

NYCTAGINACEAE

Mirabilis albida (Walt.) Heimerl, Four o'clock, *KF 464.*

OLEACEAE

Forestiera acuminata (Michx.) Poir., Swamp privet, *KF 225.*
Fraxinus americana L., White ash, *KF 609.*
Fraxinus pennsylvanica Marsh., Red ash, *JS 6683.*
Ligustrum sinense Lour., Chinese privet, *KF 717.**

ONAGRACEAE

Gaura longiflora Spach., Tall guara, *KF 492.*
Gaura parviflora Dougl. ex Lehm., Small flower gaura, *KF 952.*
Ludwigia alternifolia L., Bushy seedbox, *KF 485.*
Ludwigia decurrens Walt., Winged seedbox, *KF 646.*
Ludwigia glandulosa Walt., Creeping seedbox, *KF 440.*
Ludwigia peploides (Kunth) Raven subsp. *glabrescens* Raven, Smooth seed box, *KF 422.*
Oenothera heterophylla Spach subsp. *heterophylla*, Varileaf evening primrose, *KF 374.*
Oenothera laciniata Hill, Cutleaf evening primrose, KF *503.*
Oenothera speciosa Nutt., Showy evening primrose, *KF 270.*

OXALIDACEAE

Oxalis dillenii Jacq. subsp. *dillenii*, Dillen's wood sorrel, *KF 246.*
Oxalis violacea L., Violet wood sorrel, *KF 297*

PAPAVERACEAE

Argemone albiflora Hornem. var. *texana* (G. Owenby) Shinners, White prickly poppy, *KF 448.*

PASSIFLORACEAE

Passiflora incarnata L., Maypop passion flower, KF *617.*
Passiflora lutea L., Yellow passion flower, *KF 634.*

PHYTOLACCACEAE

Phytolocca americana L. var. *americana*, Common pokeweed, *KF 514.*

PLANTAGINACEAE

Plantago virginica L., Paleseeded plantain, *KF 497.*
Plantago wrightiana Dcne., Wright's plantain, *KF 384.*

POLYGALACEAE

Polygala polygama L. var. *obtusa* Chodat, Bitter milkwort, *KF 403.*

POLYGONACEAE

Brunnichia ovata (Walt.) Shinners, Eardrop vine, *KF 601.*
Polygonum aviculare L., Prostrate knotweed, *KF 614.*
Polygonum hydropiper L., Water smartweed, *JS 6306.*
Polygonum pensylvanicum (L.) Small, Pennsylvania smartweed, *KF 534.*
Polygonum persicaria L., Lady's thumb, *KF 692.*
Rumex chrysocarpus Moris, Interupted dock, *KF 388.*
Rumex crispus L., Curly dock, *KF 414.*
Rumex hastatulus Baldw., Heartwing dock, *JS 6181.*

PORTULACACEAE

Claytonia virginica L. var. *virginica*, Spring beauty, *KF 231.*
Portulaca umbraticola Kunth, Wingpod purslane, *KF 610.*

PRIMULACEAE

Samolus valerandi L. subsp. *parviflorus* (Raf.) Hulten, Thinleaf brookweed, *KF 361*a.

RANUNCULACEAE

Clematis pitcheri T. & G., Pitcher's clematis, *KF 348.*
Myosurus minimus L., Tiny mouse tail, *KF 230.*
Ranunculus hispidus Michx. var. *nitidus* (Chapm.) Duncan, Seaside buttercup, *KF 233.*

RHAMNACEAE

Berchemia scandens (Hill) K. Koch, Alabama supplejack, KF *285*.

Frangula caroliniana (Walt.) Gray, Carolina buckthorn, *KF 281*.

ROSACEAE

Crataegus crus-galli L., Cockspur hawthorn, *KF 295*.

Crateagus marshallii Eggl., Parsley hawthorn, *KF 277*.

Crataegus mollis Scheele, Downy hawthorn, *KF 475*.

Crataegus viridis L. subsp. viridis, Green hawthorn, *KF 293*.

Geum canadense Jacq., White avens, *KF 290*.

Prunus angustifolia Marsh. var. *angustifolia*, Chickasaw plum, *JS 6133*.

Prunus gracilis Engelm. & Gray, Sand plum, *KF 1060*.

Prunus mexicana S. Wats., Mexican plum, *JS 6134*.

Prunus serotina Ehrhart var. *serotina*, Black cherry, *KF 260*.

Rubus persistens Rydb., Persistent dewberry, *KF 693*.

Rubus riograndis Bailey, Dewberry, *JS 6132*.

Rubus trivialis Michx., Southern dewberry, *KF 1092*.

RUBIACEAE

Cephalanthus occidentalis L. var. *californicus* Benth., Buttonbush, *JS 6674*.

Diodia teres Walt. var. *teres*, Rough buttonweed, *KF 547*.

Diodia virginiana L., Virginia buttonweed, *KF 530*.

Galium aparine L., Catchweed bedstraw, *KF 498*.

Galium circaezans Michx., Woods bedstraw, *KF 278*.

Galium tinctorium (L.) J. Scopoli, Dye bedstraw, *KF 294*.

Houstonia pusilla J. Schopf, Small bluets, *KF 229*.

Oldenlandi boscii (DC.) Chapm., Bluets, *KF 228*.

RUTACEAE

Zanthoxylum clava-herculis L., Prickly ash, *KF 482*.

SALICACEAE

Populus deltoides Bart. ex Marsh. subsp. *deltoides*, Cottonwood, *KF 413*.

Salix nigra Marsh., Black willow, *JS 6696*.

SAPINDACEAE

Cardiospermum halicacabum L., Balloon vine, *KF 584*.

Sapindus saponaria L. var. *drummondii* (Hook. & Arn.) Benson, Western soapberry, *KF 273*.

SAPOTACEAE

Sideroxylon lanuginosum Michx., Woolly bucket bumelia, *JS 6690*.

SAURURACEAE

Saururus cernuus L., Lizard's tail, *KF 442*.

SCROPHULARIACEAE

Agalinis heterophylla (Nutt.) Small ex Britt., Prairie agalinis, *KF 616*.

Castilleja indivisa Engelm., Texas Indian paintbrush, *KF 232*.

Gratiola brevifolia Raf., Sticky hedge hyssop, *KF 640*.

Gratiola virginiana L. subsp. *virginiana*, Virginia hedge hyssop, *KF 313*.

Leucospora multifida (Michx.) Nutt., Narrowleaf leucospora, *KF 587*.

Nuttallanthus canadensis (L.) Sutton, Old field toadflax, *KF 236*.

Penstemon laxiflorus Penn. Loose penstemon, *KF 330*.

Verbascum thapsus L., Common mullein, *KF 720*.

Veronica agrestis L., Wayside purslane, *JS 6173*.

Veronica peregrina L., Purslane speedwell, *KF 304*.

SOLANACEAE

Physalis angulata L., Cutleaf ground cherry, *KF 588*.

Physalis mollis Nutt., Field ground cherry, *KF 670*.

Solanum ptycanthum Dun., American nightshade, *KF 677*.

Solanum carolinense L. var. *carolinense*, Carolina horse nettle, *KF 337*.

Solanum elaeagnifolium Cav., Silverleaf nightshade, *KF 333*.

TILIACEAE

Tilia americana L. var. *caroliniana* (Mill.) Castiglioni, American basswood, *KF 527*.

ULMACEAE

Celtis laevigata Willd. var. *laevigata*, Texas sugarberry, *JS 6691*.

Planera aquatica (Walt.) Gmel., Water elm, *JS 6676*.

Ulmus alata Michx., Winged elm, *KF 512*.

Ulmus americana L., American elm, *KF 509*.

Ulmus crassifolia Nutt., Cedar elm, *KF 508*.

URTICACEAE

Boehmeria cylindrica (L.) Sw., False-nettle, *KF 392*.

Parietaria pensylvanica Muhl. ex Willd., Hammerwort, *KF 299*.

Urtica chamaedryoides Pursh, Heartleaf nettle, *JS 6686.*

VALERIANACEAE

Valerianella radiata (L.) Dufr., Beaked corn salad, *KF 303.*

VERBENACEAE

Callicarpa americana L., American beautyberry, *KF 443.*

Glandularia canadensis (L.) Nutt., Rose vervain, *KF 321.*

Phyla lanceolata (Michx.) Greene, Northern frog fruit, *KF 201.*

Verbena brasiliensis Vell., Brazilian verbena, *KF 525.**

Verbena halei Small, Texas vervain, *KF 261.*

VIOLACEAE

Viola bicolor Pursh, Field pansy, *JS 6163.*

Viola missouriensis Greene, Missouri violet, *KF 222.*

Viola palmata L., Trilobe violet, *KF 292.*

Viola villosa Walt., Carolina violet, *KF 759.*

VISCACEAE

Phoradendron tomentosum (DC.) Engelm. ex Gray, Christmas mistletoe, *KF 718.*

VITACEAE

Ampelopsis arborea (L.) Koehne, Peppervine, *KF 385.*

Parthenocissus quinquefolia (L.) Planch. var. *quinquefolia*, Virgin'a creeper, *JS 6694.*

Vitis mustangensis Buckl., Mustang grape, *KF 328.*

Vitis palmata Vahl, Catbird grape, *KF 362.*

Vitis riparia Michx., Riverbank grape, *KF 367.*

Vitis rotundifolia Michx. var. *rotundifolia*, Muscadine grape, *KF 401.*

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Books Received/Notices

Annotations and comments by the Editor

Texas Floras/Natural History/Wildlife

Matt White (Foreword by Greg W. Lasley). 2002. **Birds of Northeast Texas.** (ISBN 0-58544-192-9, hbk.; 0-58544-193-7, pbk.). Texas A&M University Press, John H. Lindsey bldg, Lewis Street, 4354 TAMU, College Station, TX 77843-4354, U.S.A. (Orders: 800-826-8911, 979-847-8752 fax, WJL@tampress.tamu.edu, www.tamu.edu/upress). $44.95 (hbk), $19.95 (pbk), 160 pp., 30 color photos, map, 6" × 9".

Key Words: Texas, northeast Texas, birds, identification, field guide, zoology.

What a nice book the author has given us. The author summarizes the status of 390 species that have been reliably documented and recorded from the 22 counties of northeast Texas. "The brief species accounts explain each species' status, distribution, and period of occurrence in the region." Contents include an introduction followed by chapters on Geography of the Region, Birdwatching Areas, and Species Accounts. The color photos are very nice.

John W. Tunnell, Jr. and Frank W. Judd (Foreword by Richard C. Bartlett). 2002. **The Laguna Madre of Texas and Tamaulipas.** (ISBN 0-58544-133-3, hbk.). Texas A&M University Press, John H. Lindsey bldg, Lewis Street, 4354 TAMU, College Station, TX 77843-4354, U.S.A. (Orders: 800-826-8911, 979-847-8752 fax, WJL@tampress.tamu.edu, www.tamu.edu/upress). $60.00, 372 pp., 83 color photos, 87 figures, 45 tables, 8 1/2" × 11".

Key Words: Texas natural history, Gulf Coast, Laguna Madre Region, natural resources, environment. seagrass meadows, shorebirds and wading birds, sea turtles, fish and invertebrate fisheries organisms, red and brown tides, conservation issues.

From the authors: "This compendium is intended as an overview of the Laguna Madre for an audience of both scientists and nonscientists. It is firmly based in science but also for use by others who want to learn about and take care of the Laguna Madre now and in the future." There is a nice appendix of Laguna Madre researchers and interested parties. The literature cited is 30 pages of references.

Gunnar Brune (Introduction by Helen C. Bese). 2002. **Springs of Texas. Second Editon.** (ISBN 0-58544-196-1, hbk.). Texas A&M University Press, John H. Lindsey bldg, Lewis Street, 4354 TAMU, College Station, TX 77843-4354, U.S.A. (Orders: 800-826-8911, 979-847-8752 fax, WJL@tampress.tamu.edu, www.tamu.edu/upress). $75.00 (hbk), 608 pp., 272 b/w photos, 38 line drawings, 9 color maps, 8 1/2" × 11".

Key Words: Springs, Texas natural history, human, population explosion, 2900 springs in 183 Texas counties, decline and disappearance of springs, physical characteristics of springs, lore, flora and fauna of springs, endangered species, Texas water law.

You've never heard of so many springs. Yes, there is Rattlesnake Springs, Prairie Dog Springs, Walnut Springs, Onion Springs, Comanche Springs, and the list goes on.

FLORISTICS OF XERIC SANDYLANDS IN THE POST OAK SAVANNA REGION OF EAST TEXAS

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ABSTRACT

This study describes the floristics, soils, and small-scale species richness of xeric sandylands of the post oak savanna region of east central Texas and maps the distribution of xeric sandylands throughout the West Gulf Coastal Plain. The interrelation of xeric sandylands to wetlands and their interest for regional conservation assessment are discussed.

KEY WORDS: xeric sandylands, Post Oak Savanna, flora, Texas, Gus Engeling Wildlife Management Area.

RESUMEN

En este estudio se describe la florística, suelos, y riqueza de especies a pequeña escala de los lugares arenosos xéricos de la región de sabana post oak del centro este de Texas y se cartografía la distribución de los lugares arenosos xéricos de la llanura costera del West Gulf. Se discuten la interrelación de los lugares arenosos xéricos con los humedales y su interés para la evaluación de la conservación regional.

INTRODUCTION

During the past few years, we have been studying wetlands (muck bogs, upland marshes, baygalls, and seeps) in the post oak savanna region of east central Texas and southeastern Oklahoma (Nesom et al. 1997; MacRoberts & MacRoberts 1998b). These wetlands appear to be associated with xeric sandylands (variously referred to as oak-farkleberry sandylands [Ajilvsgi 1979], Post Oak-Black Hickory Series [Diamond et al. 1987], xeric sandylands [MacRoberts & MacRoberts 1994, 1995, 1996], Grossarenic Dry Uplands [Turner et al. 1999], Sand Post Oak - Bluejack Oak Alliance [Singhurst et al. 2000], and *Quercus incana* woodland alliance [Hoagland 2000]). These deep sands act as a reservoir or sponge holding water that feeds adjacent seeps and springs that are the headwaters for the area's wetlands and ultimately the streams and rivers. These upslope soils are porous and drain readily; rainwater percolates through the sand and moves down a gradient created by underlying impermeable or slowly permeable clays. Eventually, water seeps laterally out of the hillside (Martin & Smith 1991; Jones & Carpenter 1995; Drewa 1999; Summer 1999).

As part of our study of muck bogs, upland marshes, and their flora, we

studied these adjacent xeric sandylands since they are clearly the water source for these wetlands.

The primary objectives of this paper are to describe: 1) the distribution of xeric sandylands throughout the West Gulf Coastal Plain, 2) the floristics of this community in the post oak savanna region, 3) the small-scale species richness of this community, and 4) the soils upon which this community occurs.

In addition to our primary objectives for studying this community, we also are stimulated by a recent spate of national and regional conservation assessments (e.g., Diamond et al. 1997; Ricketts et al. 1999a, 1999b; Myers et al. 2000) that propose to pinpoint ecological "hotspots." These assessments are based on diversity, species richness, endemism, endangered species, and unique habitat availability. But, as is so often the case with such large-scale efforts, while some regions are well known, others are not. The post oak savanna region of east Texas is one of the poorest known. This is evident upon examining recent regional descriptions of the area (e.g., McNab & Avers 1994; Keys et al. 1995; Ricketts et al 1999a), where numerous factual errors lead to inaccurate assessments of the region's ecological "temperature."

THE SETTING

In Texas, the post oak savanna region (Fig. 1), consisting of about 30,000 sq. km, is gently rolling and hilly with elevations from 90 to 250 meters. Rainfall ranges from 75 to 115 centimeters. The Carrizo Sands are virtually coterminous with the region (McBryde 1933). Prairies are scattered throughout, notably in the south where some prairies are large (Smeins & Diamond 1983). The predominant floristic character of the region is southeastern without pines (Smeins & Diamond 1986). The area contains a diversity of plant communities, from hillside pitcher plant bogs, peat bogs, and upland marshes to open xeric sandylands and oak-hickory forests and woodlands. Characteristic communities within the post oak savanna region also occur to the east within the pineywoods (Marietta & Nixon 1983; Ward & Nixon 1992). How the post oak savanna region relates biotically to other regions in the area has yet to be studied in detail (Monk et al. 1990; Bryant et al. 1993; Skeen et. al. 1993); however, it appears to be floristically similar to adjoining regions (MacRoberts & MacRoberts pers. obs.) and has no vertebrate endemism (Telfair 1999).

McBryde (1933) conducted the only major floristic/edaphic study of the region. Subsequently, very little research has been done on the post oak savanna except for the inclusion prairies in its southern portion (Smeins & Diamond 1986).

Xeric sandylands are (or at least once were) very common in the Texas post oak savanna region, but they also occur in the pineywoods regions of southeastern Oklahoma, southwestern Arkansas, western Louisiana, eastern Texas,

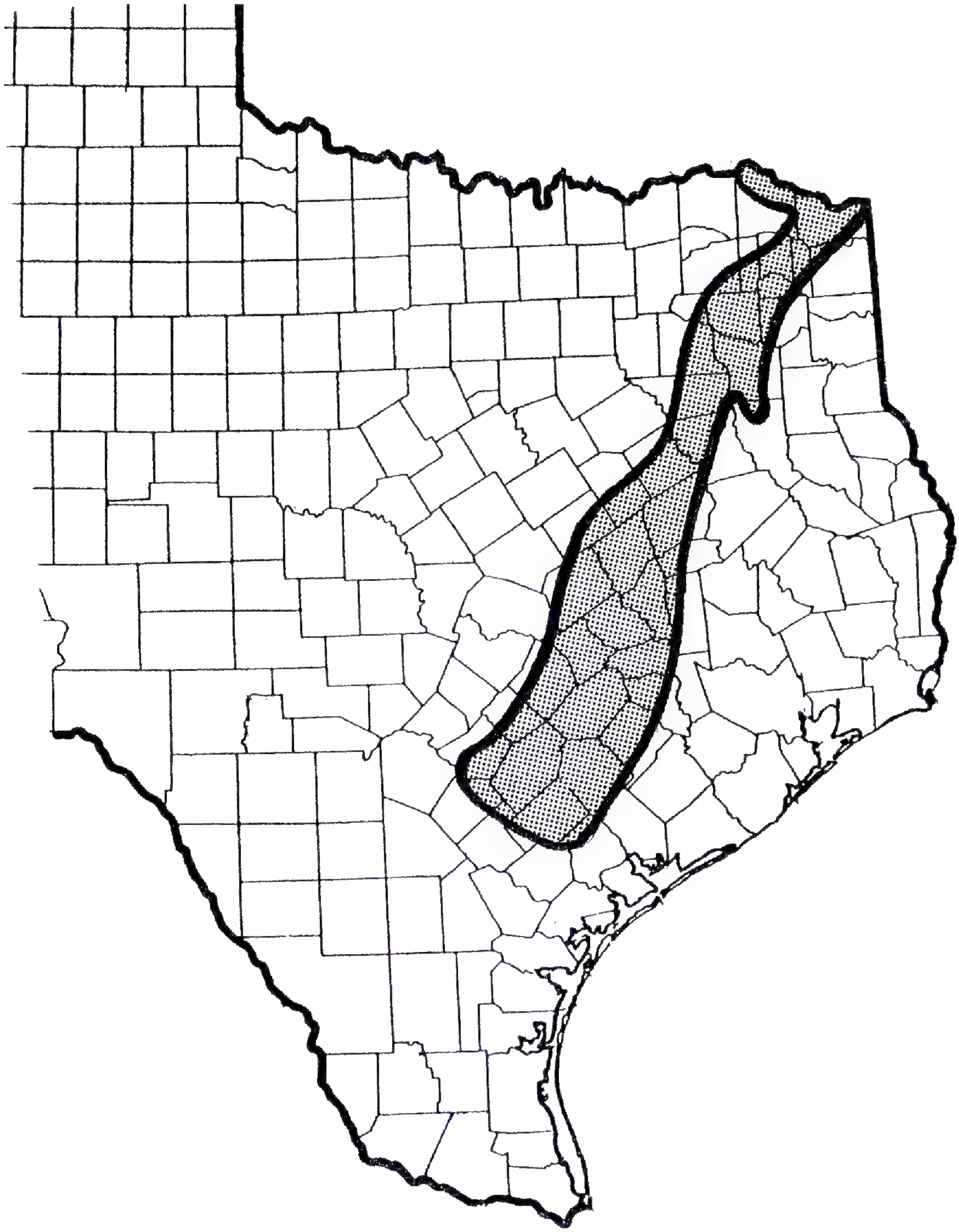


FIG. 1. Post oak savanna region of Texas.

and into the Coastal Bend of Texas (McBryde 1933; Jones 1977; Drawe et al. 1978; Taylor & Taylor 1978; Ajilvsgi 1979; Marks & Harcombe 1981; Louisiana Natural Heritage 1988; Bridges & Orzell 1989; Harcombe et al. 1993; Foti et al. 1994; MacRoberts & MacRoberts 1994, 1995, 1996; Jones & Carpenter 1995; Texas Natu-

ral Heritage Program 1995; Turner et al. 1999; Hoagland 2000). Homologues of xeric sandylands occur east of the Mississippi River (Stout & Marion 1993). It is generally assumed that oak savannas and xeric sandylands, like prairies, are kept open largely by fire (Smeins & Diamond 1986; Cutter & Guyette 1994). While encroachment of woody vegetation is ubiquitous in the absence of fire, there are many areas that remain open even when fire is suppressed, suggesting that edaphic conditions play an integral role. Characteristic tree species of xeric sandylands include *Quercus incana* W. Bartram, *Q. margarettiae* Ashe ex Small, *Q. stellata* Wangenh., and *Carya texana* Buckley, and a variety of fidel herbaceous species (see Methods for list). The area appears to be rich in plant endemism (Sorrie & Weakley 2001), and a large number of West Gulf Coastal Plain endemics are associated with this community, for example, *Brazoria truncata* (Benth.) Engelm. & A. Gray, *Palafoxia reverchonii* (Bush) Cory, *Paronychia drummondii* Torr. & A. Gray, *Pediomelum hypogaeum* (Nutt. ex Torr. & A. Gray) var. *subulatum* (Bush) J. W. Grimes, *Penstemon murrayanus* Hook., *Polanisia erosa* (Nutt.) H.H. Iltis, *Rhododon ciliatus* (Benth.) Epling, *Tetragonotheca ludoviciana* (Torr. & A. Gray) A. Gray ex Hall, *Tradescantia reverchonii* Bush, and *T. subacaulis* Bush.

METHODS

In order to develop an objective idea of the distribution of xeric sandylands, we selected 42 fidel species from the total list of species occurring in this community. We mapped these by county and parish over their ranges (Fig. 2). In the map, the number of fidels per county or parish is indicated in the legend. Parishes or counties with fewer than 10 species are left blank.

The 42 species chosen were *Astragalus leptocarpus* Torr. & A. Gray, *A. soxmaniorum* Lundell, *Berlandiera pumila* (Michx.) Nutt., *Brazoria truncata*, *Clematis reticulata* Walter, *Cnidoscolus texanus* (Muell.-Arg.) Small, *Coreopsis intermedia* Sherff, *Crataegus uniflora* Muenchh., *Croton argyranthemus* Michx., *Cyperus grayioides* Mohlenbrock, *Dalea phleoides* (Torr. & A. Gray) Shinners, *D. villosa* (Nutt.) Spreng., *Eriogonum longifolium* Nutt., *E. multiflorum* Benth., *Froelichia floridana* (Nutt.) Moq. (not distinguished from *F. gracilis* [(Hook.) Moq.]), *Hymenopappus artemisiifolius* DC., *Lithospermum caroliniense* (Walter ex J.F. Gmel.) MacMill., *Loeflingia squarrosa* Nutt., *Matelea cynanchoides* (Engelm.) Woodson, *Minuartia drummondii* (Shinners) McNeill, *Palafoxia hookeriana* Torr. & A. Gray, *P. reverchonii*, *Paronychia drummondii*, *Pediomelum digitatum* (Nutt. ex Torr. & A. Gray) Isely, *P. hypogaeum* var. *subulatum*, *Penstemon murrayanus*, *Phacelia strictiflora* (Engelm. & A. Gray) A. Gray, *Phlox drummondii* Hook., *Physalis mollis* Nutt., *Polanisia erosa* (Nutt.) H.H. Iltis, *Polygonella americana* (Fisch. & C.A. Mey.) Small, *Prunus gracilis* Engelm. & A. Gray, *Rhododon ciliatus*, *Selaginella arenicola* Underwood ssp. *riddellii* (Van Eselt.) R. M. Tryon, *Scutellaria cardiophylla* Engelm. & A. Gray, *Streptanthus*

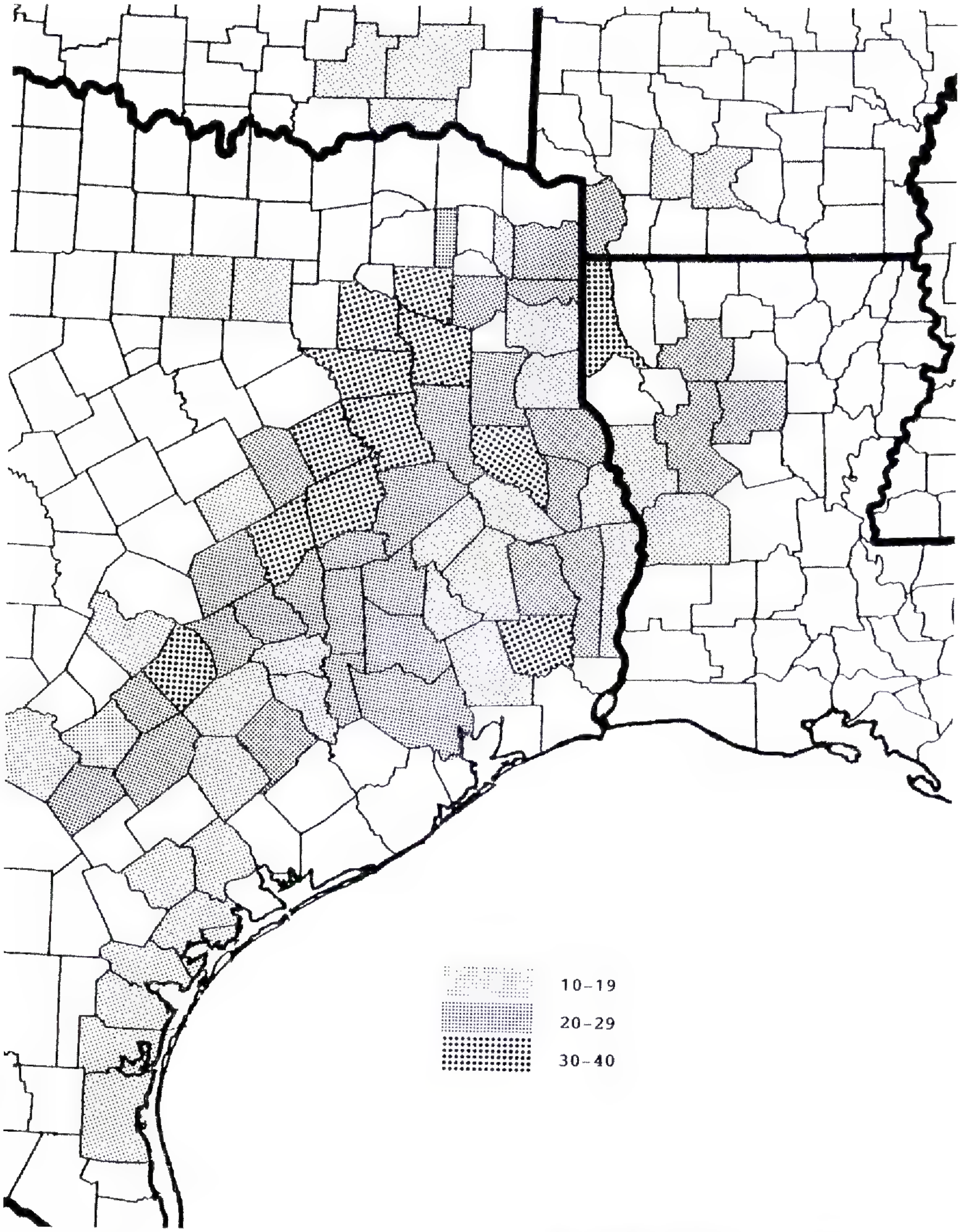


Fig. 2. Xeric sandylands species distribution (see text for key).

hyacynthoides Hook., *Stylisma pickeringii* (Torr. ex M.A. Curtis) A. Gray, *Talinum rugospermum* Holz., *Tetragonotheca ludoviciana*, *Tradescantia reverchonii*, *Yucca louisianensis* Trel., and *Zornia bracteata* J.F. Gmel. Sources for this information consisted of extensive herbarium searches, notably LSU, TAMU (both on line), ASTC, BRIT, Corpus Christi Museum of Science and History, LSUS,

SBSC, SHST, TEX, VDB, WWF, atlases (e.g., Smith 1988; Thomas & Allen 1993-1998; Turner in press), and a variety of literature (e.g., Jones 1977; Taylor & Taylor 1978; Singhurst 1996; Turner 1996; Nesom & Brown 1998) and unpublished sources (Billie Turner pers. comm.; Bruce Hoagland pers. comm.). We also made field searches throughout the West Gulf Coastal Plain to look for the species and the community *in situ*.

We surveyed the flora of xeric sandylands at Gus Engeling Wildlife Management Area (GEWMA), Anderson County, Texas, in the center of the post oak savanna region. The GEWMA occurs in the central part of the Trinity River drainage along Catfish Creek (Telfair 1988). This property consists of approximately 44 sq. km, of which 18 are the sand post oak-bluejack oak community (Singhurst et al. 2000). We established a single study plot measuring 50 m × 100 m (0.5 ha), within which was another single plot measuring 20 m × 50 m (0.1 ha) with two nested 3.16 m × 3.16 m plots (0.001 ha) and 6 nested 1 m × 1 m plots (0.0001 ha) in an opening in this community (see Peet et al. 1998 for plot design). The larger plot ran parallel to the topographic gradient and the adjacent downslope bog and was about 100 meters north of the edge of the bog and a few meters higher than the bog (see MacRoberts & MacRoberts 1998b, 1999; Singhurst et al. 2000 for a description of Andrew's Bog, GEWMA). We surveyed this area monthly from March to October 2000 and listed all plant species in each plot. This gave us information on both total floristics and species/area measures for comparison with similar measures from other plant communities. We estimated ground cover and measured vegetation height in the 0.0001 ha plots. We also surveyed several other xeric sandylands in other parts of the GEWMA. Plant nomenclature throughout this paper follows Kartesz and Meacham (1999). Voucher specimens are deposited at TEX.

We collected soil samples from the upper 15 cm of the two 0.001 ha plots and from the 0.1 ha plot for comparison with this community elsewhere in its range. These were analyzed by A & L Laboratories, Memphis, Tennessee. The soil at the study site is described as deep, well-drained acidic sandy Pleistocene terraces (Arenosa series, Typic Quartzipsammeents, Entisols) (Coffee 1975).

RESULTS

Figure 1 shows the location of the Post Oak Savanna region of East Texas in which xeric sandylands are located. Figure 2 shows the frequency of occurrence of the 42 xeric sandyland fidel species in parishes and counties in the West Gulf Coastal Plain. Counties and parishes with fewer than 10 species are left blank. Table 1 lists the species found within the 0.1 ha plot. Table 2 gives additional species in the 0.5 ha plot. Table 3 shows the number of species occurring in the 0.0001 ha, 0.001 ha, 0.1 ha, and 0.5 ha plots. Table 4 gives the ground cover and vegetation height in the six 0.0001 ha plots in May and August. Table 5 gives the soil information from the study plots.

TABLE 1. Species present in the 0.1 ha study plot at the Gus Engeling Wildlife Management Area (Anderson County, Texas).

AGAVACEAE: *Yucca louisianensis* Trel.
AMARANTHACEAE: *Froelichia floridana* (Nutt.) Moq.
ANACARDIACEAE: *Rhus aromatica* Aiton, *Toxicodendron radicans* (L.) Kuntze
APIACEAE: *Spermolepis divaricata* (Walter) Raf. ex Ser., *S. inermis* (Nutt. ex DC.) Mathias & Constance
AQUIFOLIACEAE: *Ilex vomitoria* Sol. in Aiton
ASCLEPIADACEAE: *Matelea cynanchoides* (Engelm.) Woods
ASTERACEAE: *Croptilon divaricatum* (Nutt.) Raf., *Evax candida* (Torr. & A. Gray) A. Gray, *Helianthus debilis* Nutt. ssp. *cucumerifolia* (Torr. & A. Gray) Heiser, *Krigia virginica* (L.) Willd., *Palafoxia reverchonii* (Bush) Cory, *Pyrrhopappus carolinianus* (Walter) DC., *Senecio ampullaceus* Hook., *Thelesperma filifolium* (Hook.) A. Gray
BRASSICACEAE: *Lepidium virginicum* L., *Streptanthus hyacinthoides* Hook.
CACTACEAE: *Opuntia humifusa* (Raf.) Raf.
CAPPARACEAE: *Polanisia erosa* (Nutt.) H. H. Iltis
CARYOPHYLLACEAE: *Loeflingia squarrosa* Nutt., *Paronychia drummondii* Torr. & A. Gray
CISTACEAE: *Helianthemum georgianum* Chapm., *Lechea mucronata* Raf., *L. tenuifolia* Michx.
COMMELINACEAE: *Commelina erecta* L., *Tradescantia reverchonii* Bush, *T. subacaulis* Bush
CONVOLVULACEAE: *Stylisma pickeringii* (Torr. ex M.A. Curtis) A. Gray
CRASSULACEAE: *Sedum nuttallianum* Raf.
CUPRESSACEAE: *Juniperus virginiana* L.
CYPERACEAE: *Carex cephalophora* Muhl. ex Willd., *C. retroflexa* Muhl. ex Willd., *Cyperus grayioides* Mohlenbrock
EUPHORBIACEAE: *Cnidoscolus texanus* (Muell. Arg.) Small, *Croton argyranthemus* Michx., *C. capitatus* Michx., *C. glandulosus* L., *C. michauxii* G.L. Webster
FABACEAE: *Astragalus leptocarpus* Torr. & A. Gray, *Baptisia nuttalliana* Small, *Centrosema virginiana* (L.) Benth., *Chamaecrista fasciculata* (Michx.) Greene, *Dalea phleoides* (Torr. & A. Gray) Shinners, *Indigofera miniata* Ortega, *Mimosa nuttallii* (DC.) B.L. Turner, *Pediomelum digitatum* (Nutt. ex Torr. & A. Gray) Isely
FAGACEAE: *Quercus incana* W. Bartram, *Q. margarettiae* Ashe ex Small
HYDROPHYLLACEAE: *Phacelia strictiflora* (Engelm. & A. Gray) A. Gray
KRAMERIACEAE: *Krameria lanceolata* Torr.
LAMIACEAE: *Brazoria truncata* (Benth.) Engelm. & A. Gray, *Monarda punctata* L., *Rhododon ciliatus* (Benth.) Epling
LILIACEAE: *Allium canadense* L.
MOLLUGINACEAE: *Mollugo verticillata* L.
ONAGRACEAE: *Oenothera laciniata* Hill
PLANTAGINACEAE: *Plantago hookeriana* Fisch. & C.A. Mey.
POACEAE: *Andropogon ternarius* Michx., *Aristida desmantha* Trin. & Rupr, *A. lanosa* Muhl. ex Elliott, *Dichanthelium acuminatum* (Sw.) Gould & C.A. Clark, *D. oligosanthes* (Schult.) Gould, *Paspalum setaceum* Michx., *Triplasis purpurea* (Walter) Chapm., *Vulpia elliotea* (Raf.) Fernald.
POLYGONACEAE: *Eriogonum multiflorum* Benth., *Rumex hastatulus* Baldwin.
PORTULACACEAE: *Talinum rugospermum* Holz.
ROSACEAE: *Rubus argutus* Link
RUBIACEAE: *Diodia teres* Walter
SCROPHULARIACEAE: *Nuttallanthus canadensis* (L.) D.A. Sutton
SOLANACEAE: *Physalis heterophylla* Nees
VISCACEAE: *Phoradendron tomentosum* (DC.) Engelm. & A. Gray

DISCUSSION

Xeric sandylands occur from southwest Arkansas and southeastern Oklahoma to central Louisiana and the Coastal Bend of Texas. The distribution of species numbers shown in Figure 2 results in part from differential collecting: Caddo Parish and Anderson County have been well collected while most of east Texas

TABLE 2. Species in the 0.5 ha plot not found in the 0.1 ha plot. Both plots at the Gus Engeling Wildlife Management Area (Anderson County, Texas).

Bulbostylis ciliatifolia (Elliott) Fernald	*Schizachyrium scoparium* (Michx.) Nash
Carya texana Buckley	*Scleria triglomerata* Michx.
Cenchrus spinifex Cav.	*Sisyrinchium albidum* Raf.
Corydalis micrantha (Engelm. ex A. Gray) A. Gray	*Trichostema dichotomum* L.
Glandularia canadensis (L.) Nutt.	*Vaccinium arboreum* Marshall
Mirabilis albida (Walter) Heimerl	*Verbascum thapsus* L.
Oenothera heterophylla Spach	*Vitis aestivalis* Michx.
Penstemon murrayanus Hook.	*Vitis rotundifolia* Michx.

TABLE 3. Species richness in xeric sandylands at the Gus Engeling Wildlife Management Area (Anderson County, Texas).

Plot size (ha)	No. of plots	Av. no. species (range)
0.0001	6	24.5 (19–28)
0.001	2	38.5 (35–42)
0.1	1	74
0.5	1	90

has not. Better sampling would undoubtedly fill in the picture, but the outlines are clear. We have observed the community *in situ* in Miller County, Arkansas; Bienville, Caddo, Natchitoches, Vernon, and Winn parishes, Louisiana; Atoka, Choctaw, and Pushmataha counties, Oklahoma; and Anderson, Angelina, Aransas, Bastrop, Caldwell, Cass, Cherokee, Colorado, Franklin, Gonzales, Guadulape, Hardin, Henderson, Jasper, Lee, Leon, Marion, Milam, Nacogdoches, Panola, Rusk, San Augustine, San Patricio, Shelby, Smith, Tyler, Upshur, Van Zandt, Wilson, and Wood counties, Texas. We have little experience with the Coastal Bend xeric sandylands (Drawe et al. 1978), but this community appears to have affinities with the more northern and eastern xeric sandylands and needs further study. Xeric sandlylands also occur in Hopkins, Navarro, Rains, and Williamson counties and appear to have once occurred on the boundary of Fannin and Grayson counties, Texas (Jason Singhurst, pers. comm.).

There were 74 species in the 0.1 ha plot and 90 species in the 0.5 ha plot. Other taxa in xeric sandylands at GEWMA that did not occur in our plots include *Aphanostephus skirrhobasis* (DC.) Trel., *Apocynum cannabinum* L., *Asclepias amplexicaulis* Sm., *Berlandiera pumila*, *Bouteloua hirsuta* Lag., *Delphinium carolinianum* Walter, *Descurainea pinnata* (Walter) Britton, *Eragrostis secundiflora* J. Presl., *Eriogonum longifolium*, *Hymenopappus artemisiifolius*, *Liatris elegans* (Walter) Michx., *Mirabilis albida*, *Oxalis priceae* Small, *Pediomelum hypogaeum* var. *subulatum*, *Physalis turbinata* Medik., *Polygonella americana*, *Scutellaria cardiophylla*, *Selaginella arenicola* ssp. *riddellii*, *Sideroxylon lanuginosum* Michx.,

TABLE. 4. Ground cover and vegetation height in six 0.0001 ha plots at the Gus Engeling Wildlife Management Area (Anderson County, Texas)

Plot (month)	Average height (cm)	Tallest height (cm)	Percent cover
1 (August)	20	40	20
(May)	10	55	20
2 (August)	20	30	20
(May)	10	25	30
3 (August)	20	40	20
(May)	15	35	30
4 (August)	15	50	15
(May)	10	20	20
5 (August)	20	40	20
(May)	15	30	40
6 (August)	20	45	25
(May)	15	30	40

TABLE. 5. Soil characteristics of sample plots at the Gus Engeling Wildlife Management Area (Anderson County, Texas).

		Exchangeable ions (ppm)				
Sample	pH	P	K	Ca	Mg	Organic Matter%
1	4.9	26	27	172	18	1.0
2	4.8	21	20	97	14	0.8
3	4.4	24	18	80	10	0.8

Stillingia sylvatica Garden ex L., *Tetragonotheca ludoviciana*, *Tragia urticifolia* Michx., *Triodanis perfoliata* (L.) Nieuwl., and *Vicia ludoviciana* Nutt. (see also Singhurst et al. 2000).

The ground cover varied from about 15 percent to 40 percent throughout the growing season. Non-vegetated areas always prominently showed and vegetation was never tall. In general, biomass was low and sunlight was directly on the ground.

Species richness can be measured at many scales. At scales of 0.01 ha and larger, tropical rainforests are the most species rich. However, at scales below 0.001 ha and often 0.01 ha, temperate grasslands and open savannas of the southeastern United States are the most species rich. Values of between 20 and 40 species per 0.0001 ha occur but are very uncommon (Peet et al. 1983; Walker & Peet 1983; Peet & Allard 1993; Brewer 1998; Platt 1999). Peet et al. (1983) found that for a broad range of forest and woodland types, no community type exceeded 17 species per 0.0001 ha and none averaged over 13. Even tallgrass prairies, which were the highest, averaged only 18.

While very little information exists on species richness of West Gulf

Coastal Plain plant communties, the scant small-scale information available indicates that wetland pine savannas, bogs, and upland pine savannas average around 20 species in 0.0001 ha plots (Allen et al. 1988; MacRoberts & MacRoberts 1991, 1998a; Carr 2000).

In the light of these figures, it is interesting that the GEWMA xeric sandyland plots show higher species richness at small scales than virtually all other plant communities so far measured in the southeastern United States. These xeric sandylands also show a low "z" value (about 0.19), meaning that there is basically a species doubling for every 100-fold increase in area. In the present case, a 0.0001 ha plot contains roughly one-half of the species found in a 0.01 ha plot, and one-quarter the species found in a 1.0 ha plot (see MacArthur & Wilson 1967; Harris 1984 for discussion of "z" value).

The reason for such high species counts in these small-scale plots is not clear except that, in this case, most species are relatively diminutive with a variety of growth forms (about 60 percent of the species are perennials), and many have very brief above-ground life histories. Species packing is therefore no problem.

The role of fire in maintaining plant communities is well understood (Platt 1999). In the absence of fire, many plant communities (e.g., prairies) are rapidly invaded by shrubs and trees (Packard & Mutel 1997). Oak-hickory savannas and xeric sandylands appear to require fire for natural maintenance (Cutter & Guyette 1994). We noticed in this study that, because of the long drought that the West Gulf Coastal Plain has been experiencing, there has been a significant die-off of woody vegetation, notably in the dryer areas. Fire, therefore, may not be the only important force preventing woody invasion. Periodic droughts may be another factor keeping xeric sandylands, as well as other communities, open.

Soils at GEWMA are virtually identical to soils tested from xeric sandyland sites in Louisiana and east Texas (MacRoberts & MacRoberts 1994, 1995, 1996). They are nutrient-poor and acidic. Soil conditions per se may also preclude woody invasion.

We have emphasized the floristics of xeric sandylands largely to develop baseline information, and we note that the species richness of this community is considerably greater than generally recognized. The hydrologic and geomorphologic properties of these xeric sandhills also are significant, as the water they supply underlies the existence of adjacent wetland communities—bogs, marshes, baygalls, and seeps.

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EFFECTS OF FIRE ON TWO PITCHER PLANT BOGS WITH COMMENTS ON SEVERAL RARE AND INTERESTING PLANTS

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ABSTRACT

Pitcher plant bogs require frequent fires to prevent encroachment of woody vegetation. Little information is available on the relative effectiveness of growing-season burns for maintaining plant communities in bogs and reducing woody encroachment. In this study, the effects of growing-season and dormant-season burns on plant communities were assessed in two pitcher-plant bogs on the Peason Ridge Military Reservation in western Louisiana. Measurements were collected every month from March through November 1996 and from March through October 1997. Floristic composition and forb and woody plant density were determined in both bogs. Both bogs had been burned on 3-year rotations in the dormant season for approximately 20 years. One bog, hereafter Coneflower bog, was burned during the dormant season in December 1995 and is approximately 0.8 hectare (ha). The other bog, Woodpecker bog, was burned during the growing season in August 1996 and is approximately 0.7 ha. Over both years, we found 98 plant species in both bogs together with 94 of the 98 species in Coneflower bog and 90 of the 98 species in Woodpecker bog. No species were eliminated from either bog after the fires. In addition, all species that were present after the growing season fire in Woodpecker bog had been present before the fire. However, several species were much more abundant after the fire than before the fire. The study also contains comments on the occurrence of several rare and interesting species encountered during this study including Sabine coneflower (*Rudbeckia scabrifolia*), Texas pipewort (*Eriocaulon texense*), Red-top panicum (*Panicum rigidulum* var. *combsii*), Slender panicum (*Panicum tenerum*), Beakrush (*Rhynchospora chalarocephala*), Drummond's yellow-eyed grass (*Xyris drummondii*), and Rough-leaved yellow-eyed grass (*Xyris scabrifolia*).

RESUMEN

Las turberas requieren frecuentes fuegos para evitar la invasión de vegetación leñosa. Está disponible poca información sobre la relativa efectividad de los fuegos en la época de crecimiento para mantener las comunidades vegetales en turberas y reducir la invasión de vegetación leñosa. En este estudio, se evaluaron los efectos de las quemas en la estación de crecimiento y en la época de parada de comunidades vegetales en dos turberas en la Reserva Peason Ridge Military en el oeste de Louisiana. Las medidas se tomaron todos los meses de marzo a noviembre de 1996 y de marzo a octubre de 1997. Se determinó la composición florística y densidad de hierbas y plantas leñosas en ambas turberas. Ambas turberas han sido quemadas en rotaciones de tres años en la estación de parada durante unos 20 años. Una turbera, concretamente la Coneflower, se quemó en diciembre de 1995 y tiene aproximadamente 0.8 hectáreas (ha). La otra, Woodpecker, se quemó durante la estación de crecimiento en agosto de 1996 y tiene aproximadamente 0.7 ha. Durante ambos años, encontramos 98 especies en ambas turberas junto con 94 de las 98 especies en la turbera Coneflower y 90 de las 98 especies en la turbera Woodpecker. Ninguna especie fue eliminada de las turberas después de los

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fuegos. Además, todas las especies que estaban presentes después del fuego en la estación de crecimiento en la turbera Woodpecker estaban presentes antes del fuego. Sin embargo, varias especies eran mucho más abundantes después del fuego que antes. El estudio también contiene comentarios sobe la presencia de varias especies raras e interesantes encontradas durante este estudio incluyendo *Rudbeckia scabrifolia*, *Eriocaulon texense*, *Panicum rigidulum* var. *combsii*, *Panicum tenerum*, *Rhynchospora chalarocephala*, *Xyris drummondii*, y *Xyris scabrifolia*.

INTRODUCTION

Pitcher plant bogs are unique ecosystems found in the southeastern United States. In western Louisiana, they occur in Beauregard, Natchitoches, Rapides, Sabine and Vernon parishes (Allen et al. 1988; Correll & Correll 1972.) Similar pitcher plant bogs can be found in adjacent counties in East Texas as well as areas in southeast Louisiana and eastward to Georgia and Florida (Folkerts 1982; Nixon & Ward 1986). Pitcher plant bogs typically contain saturated sandy soils underlain by an impervious sandstone or clay layer. Water that percolates through the sandy soil and reaches the impervious layer seeps to the surface. Mudstone from the Catahoula Formation usually forms the impermeable layer in bogs in the Peason Ridge area (Hart & Lester 1993).

Pitcher plant bogs are declining in quantity and quality throughout their range. Approximately 97% of pitcher plant bogs have been destroyed or severely altered since European settlement (Folkerts 1982). Public lands are virtually the only areas that this ecosystem can be managed effectively. Pitcher plant bogs require frequent fires to prevent woody encroachment (Folkerts 1982). The absence of fire results in eventual elimination of bog species (Folkerts 1982). Until recently, the flora of pitcher plant bogs was relatively unknown and little information is available on the relative effectiveness of fire for maintaining plant communities in bogs and reducing woody encroachment (Barker & Williamson 1988). Kral (1955), MacRoberts and MacRoberts (1988, 1990, 1991, 1992, 1993), and Nixon and Ward (1986) have recently conducted valuable research on the floristics of bogs in this region, but information is scarce on the effects of growing-season burns on pitcher plant bogs in the West Gulf Coast Plain. This project assesses the effects on vegetation of a growing season fire on a pitcher plant bog compared to a bog burned during the dormant season. We will also comment on several rare and interesting plants encountered during our study.

STUDY SITE/METHODS

The study area was located on Peason Ridge of the Fort Polk Military Reservation at 31° 20' 05"N 93° 17' 00"W. The area surrounding the study sites is an open, sandy longleaf pine forest with gently rolling hills and is dominated by herbaceous vegetation in the under story. The two bogs, hereafter Woodpecker bog and Coneflower bog, are located approximately 100 m apart and are separated by a narrow upland longleaf ridge. They are both open and relatively flat (2% slope) with a few scattered old growth longleaf pines and are composed mainly

of herbaceous vegetation with a few scattered small trees, shrubs, and vines. A small creek runs along the eastern side of both of the bogs. Both bogs were visited monthly from March through November 1996 and from March through October of 1997. The two bogs were chosen because of their close proximity, similar slope and aspect, and because no bog floristic studies have been conducted on Peason Ridge. The nearest study conducted on bogs was 20 km to the northeast of the study site in the Kisatchie District of the Kisatchie National Forest (MacRoberts & MacRoberts 1988.) Woodpecker bog is approximately 0.7 ha, and Coneflower bog is approximately 0.8 ha. Ten 1 × 1 m plots were spaced in a random pattern in each of the bogs (Fig. 1). Herbaceous and woody plant measurements were collected in each of the ten plots. Measurements included species frequency of occurrence and density.

Five 5 × 5 m randomly selected quadrates were also used to measure woody stem density in Woodpecker bog (Fig. 1). Measurements of woody stems were collected in May of 1996 before the summer burn and again in May of 1998 after the burn to allow for a full growing season. Woody stems over 1 m tall were also counted to record the number of mature plants. The growing-season burn in Woodpecker bog was conducted on 20 August 1996 in the afternoon with southerly winds and was effective in completely eliminating most herbaceous and leafy material. Coneflower bog was burned in December 1995.

We follow MacRoberts (1989) and Allen (1992) for scientific nomenclature. Voucher specimens for some species were deposited at the University of Louisiana-Monroe and the Botanical Research Institute of Texas (BRIT).

RESULTS AND DISCUSSION

Burn Affects

We recorded a total of 98 species in both bogs, 94 species in Coneflower bog and 90 species in Woodpecker bog. In Table 1, we list the species present in both bogs; "C" indicates species found only in Coneflower bog, "W" indicates species found only in Woodpecker bog, no letter indicates a species that was found in both bogs. White-topped sedge (*Dichromena latifolia*), Red milkweed (*Asclepias rubra*), and Longleaf milkweed (*Asclepias longifolia*) were the only species found exclusively in Coneflower bog. Species more abundant in Coneflower bog were Bog-buttons (*Lachnocaulon anceps*), Drum heads (*Polygala cruciata*), and Sabine coneflower (*Rudbeckia scabrifolia*). Texas pipewort (*Eriocaulon texense*), Narrow leaved-sunflower (*Helianthus angustifolius*), and Rough-leaved yellow-eyed grass (*Xyris scabrifolia*), and red-top panicum (*Panicum rigidulum* var. *combsii*) were the only species found exclusively in Woodpecker bog. In addition, Rose pogonia (*Pogonia ophioglossiodes*) and Meadow beauty (*Rhexia petiolata*) were much more abundant in Woodpecker bog (Table 2).

Several species numbers were significantly affected by each of the burn treatments (Table 2). Pitcher plant (*Sarracenia alata*) numbers were similar

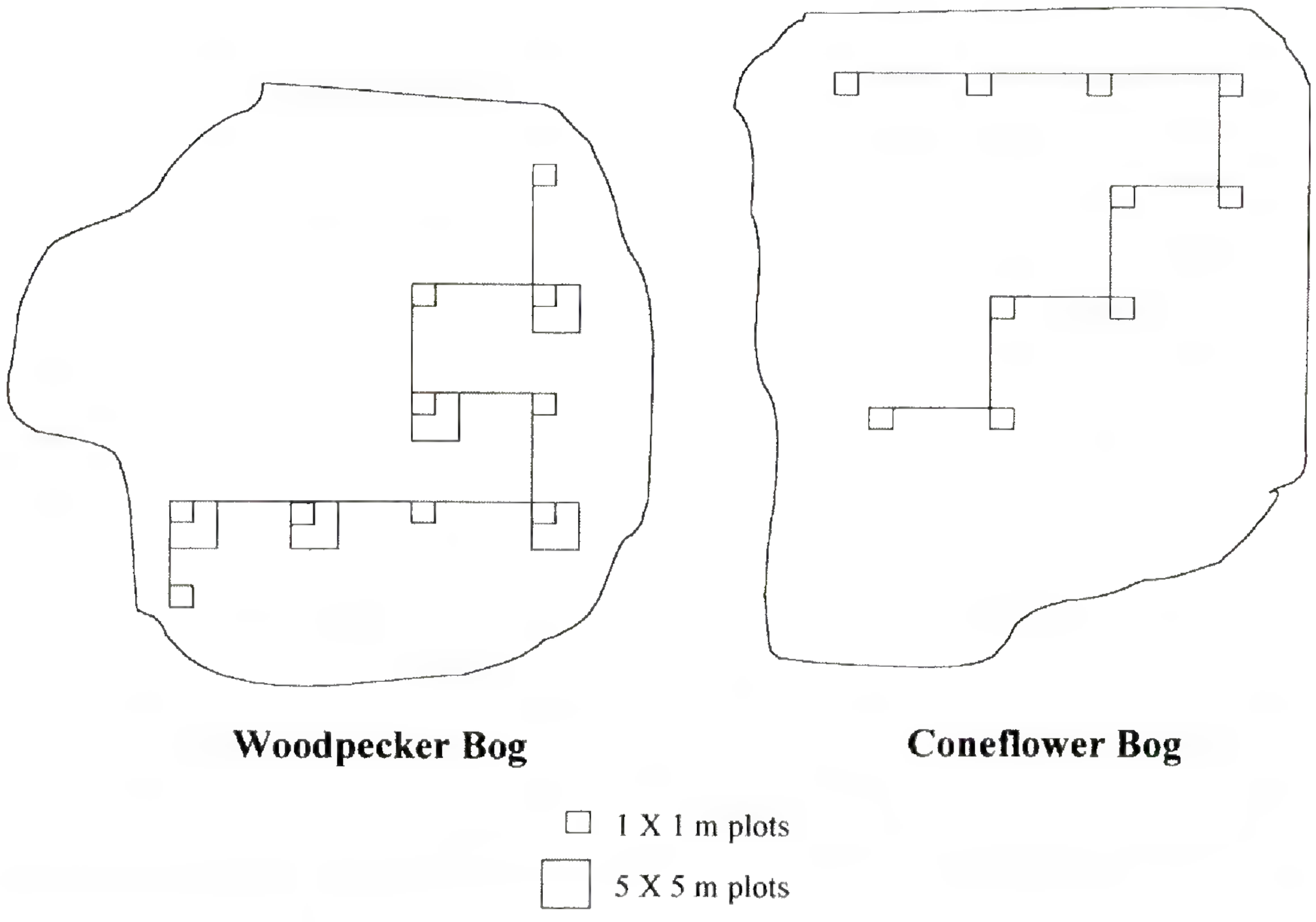


Fig. 1. Plot locations in both bogs.

before and after the growing-season burn. Before the fire, a total of 392 phyllodia were present in the ten one meter plots. One month after the fire, 383 phyllodia were counted, and in the next growing season, 395 phyllodia were present. This burn maintained the number of individuals present, contrary to the findings of Barker and Williamson 1988. They indicated a 24% increase in the number of phyllodia present in the growing season after a winter fire. A 3% increase in the number of phyllodia occurred in Woodpecker bog after this burn. However, in Coneflower bog, 463 phyllodia were present in the ten plots immediately after the fire and only 321 phyllodia were present the next growing season representing a 31% decrease in the number of phyllodia present between subsequent growing seasons. This decrease in phyllodia appears to be due to increased competition from other vegetation that returned after the fire.

Our study and previous studies suggest frequent fires are necessary to maintain the density of certain species over time. Barker and Williamson (1988) indicated an annual decay rate of 36% in *Sarracenia alata* phyllodia in an unburned bog in St. Tammany Parish, Louisiana. At this rate of decay, pitcher plants would lose 95% of their foliage in only 6 years (Barker & Williamson 1988). Bog buttons (*Eriocaulon decangulare*) displayed similar results in our study. We found 41 plants before the growing-season burn and 40 plants after the burn. However, in Coneflower bog, this species declined 59%, from 51 to 21, in just one

TAB_E 1. Taxa present in both bogs.

Lycopodiaceace—*Lycopodium appressum* (Chapm.) Lloyd & Underw.; *Lycopodium carolinianum* L.
Osmundaceae—*Osmunda cinnamomea* L.
Pinaceae—*Pinus palustris* P. Mill.; *Pinus taeda* L.
Amaryllidaceae—*Hypoxis rigida* Chapm.
Burmanniaceae—*Burmannia capitata* (Walt.) Mart.
Cyperaceae—*Carex glaucescens* Ell.; *Dichromena latifolia* Baldw. ex. Ell., **(C)**; *Eleocharis tuberculosa* (Michx.) Roem. & Schult.; *Fuirena squarrosa* Michx.; *Rhynchospora chalaro cephala* Fern. & Gale; *Rhyncospora gracilenta* A. Gray; *Rhynchospora oligantha* A. Gray; *Rhynchospora plumosa* Ell.; *Rhynchospora rariflora* (Michx.) Ell.; *Scleria reticularis* Michx.
Eriocaulaceae—*Eriocaulon decangulare* L.; *Eriocaulon texense*, **(W)** Koern.; *Lachnocaulon anceps* (Walt.) Morong.
Juncaceae—*Juncus scirpoides* Lam.; *Juncus trigonocarpus* Steud.
Liliaceae—*Aletris aurea* Walt.; *Smilax laurifolia* L.
Orchidaceae—*Calpogon tuberosus* (L.) B.S.P.; *Pogonia ophioglossoides* (L.) Juss.; *Spiranthes cernua* (L.) L.C. Rich.
Poaceae—*Andropogon gyrans* Ashe; *Antha enantia rufa* (Ell.) Schult.; *Anthaenantia villosa* (Michx.) Beauv.; *Aristida palustris* (Chapm.) Vasey; *Eragrostis refracta* (Muhl.) Scribn.; *Muhlenbergia capillaris* (Lam.) Trin.; *Panicum dichotomum* L.; *Panicum ensifolium* Baldw. ex. Ell.; *Panicum rigidulum* Nees. var. *combsii* (Scribn. & Ball), **(W)**; *Panicum scabriusculum* Ell.; *Panicum tenerum* Beyr.; *Panicum verrucosum* Muhl.; *Panicum virgatum* L.; *Paspalum floridanum* Michx.; *Schizachyrium scoparium* (Michx.) Nash; *Schizachyrium tenerum* Nees; *Tridens ambiguus* (Ell.) Schultes.
Xyridaceae—*Xyris ambigua* Bey. ex. Kunth.; *Xyris baldwiniana* Schultes; *Xyris drummondii* Malme; *Xyris scabrifolia* Harper, **(W)**.
Aceraceae—*Acer rubrum* L.
Anacardiaceae—*Toxicodendron vernix* (L.) Kuntze.
Apiaceae—*Eryngium integrifolium* Walt.; *Oxypolis rigidior* (L.) Raf.; *Ptlimnium costatum* (Ell.) Raf.
Aquifoliaceace—*Ilex coriacea* (Pursh.) Chapm.
Asclepiaceae—*Asclepias longifolia* Michx., **(C)**.; *Asclepias rubra* L., **(C).**
Asteraceae—*Aster dumosus* L.; *Cacalia ovata* Walt.; *Chaptalia tomentosa* Vent.; *Coreopsis linifolia* Nutt.; *Eupatorium leucolepsis* (DC.) Torrey & Gray; *Eupatorium rotundifolium* L.; *Helianthus angustifolius* L., **(W)**; *Heterotheca graminifolia* (Michx.) Shinners; *Liatris pynchostachya* Michx.; *Marshallia tenuifolia* Raf.; *Rudbeckia scabrifolia* Brown.
Campanulaceae—*Lobelia reverchonii* B.L. Turner
Caprifoliaceae—*Viburnum nudum* L.
Clusiaceae—*Hypericum galioides* Lam.; *Hyperi cum hypericoides* (L.) Crantz; *Hypericum stans* (Michx.) Adams & Robson.
Droseraceae—*Drosera capillaris* Poir.
Ericaceae—*Vaccinium corymbosa* L.
Euphorbiaceae—*Crotonopsis elliptica* Willd.
Gentianaceae—*Bartonia paniculata* (Michx.) Muhl.; *Sabatia gentianoides* Ell.
Lamiaceae—*Scutellaria integrifolia* L.
Lentibulariaceae—*Pinguicula pumila* Michx.; *Utricularia cornuta* Michx.; *Utricularia subulata* L.
Loganiaceae—*Cynoctonum sessilifolium* (Walt.) St. Hil.
Magnoliaceae—*Magnolia virginiana* L.
Melastomataceae—*Rhexia lutea* Walt.; *Rhexia mariana* L.; *Rhexia petiolata* Walt.
Myricaceae—*Myrica cerifera* L.; *Myrica heterophylla* Raf.
Nyssaceae—*Nyssa sylvatica* Marsh.
Onagraceae—*Ludwigia hirtella* Raf.
Polygalaceae—*Polygala cruciata* L.; *Polygala ramosa* Ell.
Rosaceae—*Aronia arbutifolia* (L.) Pers.
Sarraceniaceae—*Sarracenia alata* Wood.
Scrophulariaceae—*Agalinis purpurea* (L.) Penn.; *Gratiola pilosa* Michx.
Violaceae—*Viola primulifolia* L.

TABLE 2. Species significantly affected by fire treatments. * Coneflower bog was burned in December 1995.

	Number of stems					
	Woodpecker bog			Coneflower bog*		
Species	Pre-burn (96)	Post-burn (97)	% Change	1996	1997	% Change
Sarracenia alata	392	395	<1	463	321	-31
Aletris aurea	2	13	550	3	12	300
Coreopsis linifolia	1	18	1700	21	1	-95
Drosera capillaris	2	35	1650	19	6	-68
Eriocaulon decangulare	41	40	<1	51	21	-59
Lycopodium carolinianum	9	42	367	26	179	588
Marshallia tenuifolia	4	132	3200	104	11	89
Mitreola sessilifolia	0	27	-	1	6	500
Pogonia ophioglossiodes	6	54	800	1	5	400
Polygala cruciata	1	27	2600	11	7	-36
Polygala ramosa	2	37	1750	0	16	
Rhexia petiolata	14	85	507	2	6	200
Viola primulifolia	0	14	-	23	12	-48
Xyris ambigua	7	21	200	3	5	67
Xyris baldwiniana	30	151	403	118	97	-18
Xyris drummondii	2	20	900	0	4	
Xyris *scabrifolia*	1	9	800	0	0	

growing season. Pitcher plants and bog buttons appear to require frequent fires to maintain their presence.

Other species that also increased immediately after fire and declined after one growing season were Colic root (*Aletris aurea*), *Cynoctonum sessifolium*, milkworts (*Polygala cruciata* and *Polygala ramosa*), Rose pogonia (*Pogonia ophioglossiodes*), Meadow beauty (*Rhexia petiolata*), and Primrose-leave violet (*Viola primulifolia*) (Table 2). Unlike these species, Club moss (*Lycopodium caroliniana*) continued to increase a year after the dormant-season burn. The number of stems continued to increase, from 26 to 179, a year after the dormant-season burn in Coneflower bog. Perhaps this moss-like prostrate species requires more than one growing season to maximize the number of reproductive shoots that it produces.

The total number of woody stems increased after the growing-season burn, however, woody stems greater than one meter tall decreased. (See Table 3 for woody stem counts before and after the growing-season fire.) This increase in stems after the fire can be attributed to the large number of root sprouts from the base of the small hardwood trees, shrubs, and vines. Several small stems replaced one large stem that had been top killed by the fire. However, many shrubs were completely killed by the fire with no root sprouting. Sweet bay

TABLE 3. Woody stem totals in the five 5 × 5 m plots in Woodpecker Bog.

	Total number of stems			Stems over 1 meter tall		
Species	**Pre-burn**	**Post-burn**	**% Change**	**Pre-burn**	**Post-burn**	**% Change**
Aronia arbutifolia	6	41	583	1	2	100
Magnolia virginiana	20	17	-15	11	7	-36
Myrica cerifera	11	14	27	1	1	0
Myrica heterophylla	327	359	10	83	25	-70
Nyssa sylvatica	5	13	160	2	3	50
Pinus palustris	1	1	0	1	1	0
Pinus taeda	7	6	-14	6	6	0
Rhus vernix	0	6	-	0	3	-
Smilax laurifolia	7	39	457	5	39	680
Vaccinium corymbosa	0	6	-	0	4	
Total stems	384	502	31	110	91	-17

(*Magnolia virginiana*) and Loblolly pine (*Pinus taeda*) were the only species that decreased after the fire. In addition, Poison sumac (*Rhus vernix*) and Blueberry (*Vaccinium corymbosum*) were not present in the plots before the fire, but six plants of each species were found in the plots after the fire.

Species Encountered

Rudbeckia scabrifolia was common in the wetter areas of both bogs. This site is the northernmost record for this species. MacRoberts and MacRoberts (1993) did not record this species in Natchitoches Parish and did not find it in their study sites in the Kisatchie National Forest (MacRoberts & MacRoberts 1988, 1990, 1991, 1992). However, our study site is only 2.5 kilometers south of the Natchitoches Parish line suggesting *Rudbeckia scabrifolia* could be found in this parish and elsewhere on Peason Ridge.

Eriocaulon texense was frequent in Woodpecker bog, but not present in Coneflower bog. This plant was the only species that was found commonly in one bog and was absent in the other. This occurrence could also be the northernmost location for this species. MacRoberts and MacRoberts (1993) noted that they did not find this species in the Kisatchie District of the Kisatchie National Forest. The location of this species is approximately 20 kilometers north of any other known location.

Panicum rigidulum var. *combsii* was very uncommon in Woodpecker bog with only two small clumps found, and it was completely absent from Coneflower bog. This occurrence is only the second record for this distinctive variety in Louisiana (Allen 1992).

Panicum tenerum was common in both bogs. This plant was not found on Peason Ridge in a floristic survey (Hart & Lester 1993) and is rare in bogs and flatwoods in the southern part of the state (Allen 1992).

Rhynchospora chalarocephala was abundant in both bogs. MacRoberts and MacRoberts (1993) found this species in two bogs in the Kisatchie District and one bog in the Vernon District. They suggested that this species could be more common than previously believed. We have seen this species quite commonly in many bogs on Fort Polk and on Peason Ridge.

Xyris drummondii was common in wet, bare ground in both bogs as well as many other bogs on Peason Ridge and Fort Polk. This species seems to be more common than previously documented.

Xyris scabrifolia increased drastically after the growing season burn. We found 1 stem in our plots and three stems outside the plots before the burn. After the burn, we found 9 stems in our plots and 50 stems outside the plots. Godfrey and Wooten (1979) suggest that this is the rarest entity of *Xyris* in the southeastern United States, known only from Florida and Georgia. It is possible that this species could be more common than previously thought. In addition, it has been found recently in several locations on Fort Polk (Hart & Lester 1993).

The goal of this study was to collect observational data before and after prescribed fires in two pitcher plant bogs. Although it would have been optimal to collect data in many bogs over several years burned in different growing seasons, logistical problems and other duties prevented such a comprehensive study. Based on data collected through observations over two growing seasons, we conclude numerous bog species respond drastically to fire. The life history and habits of those species suggest frequent burns may be necessary to maintain the unique bog ecosystem. We predict future fire ecology studies will further support the necessary role of fire in the bog ecosystem.

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Books Received/Notices

Annotations and comments by the Editor

Texas Floras/Natural History/Wildlife

Roland H. Wauer and Carl M. Fleming. 2002. **Naturalist's Big Bend: An Introduction to the Trees and Shrubs, Wildflowers, Cacti, Mammals, Birds, Reptiles and Amphibians, Fish, and Insects.** (ISBN 0-58544-156-2, pbk.; 0-58544-155-4, hbk.). Texas A&M University Press, John H. Lindsey bldg, Lewis Street, 4354 TAMU, College Station, TX 77843-4354, U.S.A. (Orders: 800-826-8911, 979-847-8752 fax, WJL@tampress.tamu.edu, www.tamu.edu/upress). $29.95 (hbk), $15.95 (pbk), 208 pp., 15 color photos, 28 b/w photos, 90 line drawings, 6" × 9".

Key Words: Texas natural history, Big Bend, identification, field guide, zoology, botany, trees and shrubs, wildflowers, cacti, mammals, birds, reptiles, amphibians, fish, butterflies, invertebrates.

This is quite an impressive little guide to Big Bend. The 90 line drawings are of the more common trees, shrubs, and wildflowers. Good job. The 41-page bibliography is roughly 20% of the book. Although not intended to be a complete list of publications, it sure is a nice contribution in one place.

David J. Schmidly (forewords by Andrew Sansom and Robrt J.Potts, afterword by Clyde Jones). 2002. **Texas Natural History: A Century of Change.** (ISBN 0-89672-469-7, hbk.). Texas Tech Press, Box 41037, Lubbock, TX 79409-1037, U.S.A. (Orders: 800-832-4042, www.ttup.ttu.edu, ttup@ttu.edu). $39.95 (hbk), 576 pp., 144 b/w photos, 43 maps, 6" × 9".

Key Words: Science, natural history, Texas, U.S. biological survey, wildlife heritage, mammals, plants, natural environment, changes in landscapes, land use, early twentieth century, wildlife conservation.

This is quite an accomplishment on Texas history. The author, Dr. David J. Schmidly, is president of Texas Tech University. Congratulations on a tremendous resource for Texas!

Systematics/Monographs/Floras/Guides

Tom S. Cooperrider, Allison W. Cusick, and John T. Kartesz (eds). 2002. **Seventh Catalog of the Vascular Plants of Ohio.** (ISBN 0-8142-0858-4, hbk.; 0-8142-5061-0, pbk.). The Ohio State University Press, Columbus, OH U.S.A., www.ohiostatepress.org. (Orders: University of Chicago Distribution Center, 11030 S Landley Ave., Chicago, IL 60628, U.S.A.; 800-621-2736). $29.95 (pbk), 195 pp., 8" × 9 1/2".

Key Words: Botany, Ohio, classification, vascular plants, catalog, checklist, systematics.

NATIVE FLOWERING PLANT SPECIES NEW OR OTHERWISE SIGNIFICANT IN KENTUCKY

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ABSTRACT

Twelve species or varieties of vascular plants, all native to the southeastern U.S.A, are reported as new or noteworthy for Kentucky. Ten of these are the first documented records for the state: *Bromus nottowayanus*, *Carex corrugata*, *C. oklahomensis*, *C. ouachitana*, *C. oxylepis* var. *pubescens*, *C. roanensis*, *Eleocharis tuberculosa*, *Gentiana andrewsii*, *Vaccinium erythrocarpum*, and *Viburnum lantanoides*. Additional counties are reported for two rare species: *Carex buxbaumii* and *C. seorsa*

RESUMEN

Se presentan 12 especies o variedades de plantas vasculares, todas nativas de la región sudeste de los Estados Unidos y se citan como nuevas o de interés para el estado de Kentucky. Diez de estas plantas son las primeras citas documentadas del estado que son: *Bromus nottowayanus*, *Carex corrugata*, *C. oklahomensis*, *C. ouachitana*, *C. oxylepis* var. *pubescens*, *C. roanensis*, *Eleocharis tuberculosa*, *Gentiana andrewsii*, *Vaccinium erythrocarpum*, y *Viburnum lantanoides*. Al nivel del condado, se presentan dos especies raras: *Carex buxbaumii* y *Carex seorsa*.

INTRODUCTION

Recent field and herbarium work have resulted in the discovery of several species of native flowering plants new to Kentucky or very rare in the state. These findings will update Kentucky distribution records as listed by Beal and Thieret (1986), Browne and Athey (1992), and Medley (1993). Kentucky rarity status—Special Concern, Threatened, Endangered, or Historical, is based on KSNPC (2000, 2001). Additional information on Clinton County records is provided by Gorton (2000). Terminology for physiographic regions is based on Browne and Athey (1992), and herbarium abbreviations follow Holmgren et al. (1990).

TAXA NEW OR OTHERWISE SIGNIFICANT FOR KENTUCKY

Bromus nottowayanus Fernald (POACEAE). Though Kentucky is well within the geographic range of this species as provided by Pavlick (1995), this record is apparently the first published for the state. Almost certainly, earlier Kentucky collections exist for this woodland grass.

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Voucher specimen: **Kenton Co.:** mesic deciduous forest, Independence, 10 Aug 1995, *R. Naczi 4911 & B. Dalton* (KNK).

Carex buxbaumii Wahlenb. (CYPERACEAE). This is the second county in Kentucky documented for this species. Earlier records for this species are from Ballard County, in the westernmost portion of Kentucky, in the Coastal Plain region (Medley 1993). These records are over 20 years old, and the species is currently listed in Kentucky as Historical. This collection therefore provides a redocumentation of the species for the state, and is also the first record from the Mississippian Plateau region of the state. Kentucky is near the southern limit of this species; east of the Mississippi River, it ranges south to North Carolina and Tennessee (Radford et al. 1968; Gleason & Cronquist 1991; Chester et al. 1993).

Voucher specimen: **Clinton Co.:** hardwood swamp NW of Albany, 20 May 1999, *R. Naczi 8008* (DOV, EKY, KNK).

Carex corrugata Fernald (CYPERACEAE). These specimens represent the first record of the species from the state. Kentucky is the northern limit of this sedge, which is most common on river floodplains in the Coastal Plain of the southeastern U.S.A. (Naczi 1992). Most of the collections cited here are from sites along the Ohio or Mississippi rivers.

Voucher specimens: **Butler Co.:** Mudd River/Green River junction at Butler/Muhlenberg County line, 3 May 1995, *L. McKinney 6373* (MICH). **Campbell Co.:** Silver Grove, forested floodplain of Ohio River, 12 May 1995, *R. Naczi 4581 & J. C. Ganss* (DOV, MICH); Melbourne, forested floodplain of Ohio River, 17 May 1999, *R. Naczi 7874* (DOV). **Fulton Co.:** SW of Hickman, 5 May 1990, *L. McKinney 4124* (EKY). **Hardin Co.:** Prewitt's Lake, 29 May 1977, *R. Cranfill 239a* (MICH). **McCracken Co.:** Reidland, 26 May 1969, *R. Athey 641* (MUR). **Union Co.:** near Caney Mound School, 6 Jul 1936, *H. Shacklette 401* (GH).

Carex oklahomensis Mack. (CYPERACEAE). These specimens represent the first record of the species from the state. This species also occurs in the midwestern U.S.A., from Missouri and Kansas south to Texas, and in the eastern U.S.A. in Mississippi, North Carolina, Tennessee, and Virginia (Jones & Reznicek 1995; Bryson et al. 1996; Wieboldt et al. 1998).

Voucher specimens: **Calloway Co.:** wet fallow field, Snipe Creek Embayment, 5 Jun 1989, *J. Grubbs 1501* (MUR). **McCracken Co.:** wet ditches on the Ichneidman Road, 24 May 1970, *R. Athey 932* (KNK, MUR). **Marshall Co.:** wet woods, Sharp Elva Road off US 68, 10 May 1972, *R. Athey 1666* (MUR).

Carex ouachitana Kral, Manhart & Bryson (CYPERACEAE). This recently described sedge is known from sites in western Arkansas and eastern Oklahoma (Kral et al. 1987; Naczi & Bryson 1990), and a single site in Clay County, Tennessee (McNeilus 1992). This collection from Clinton County, Kentucky, only a few km from the Clay County site, represents a new record for Kentucky, and the second record of the species from east of the Mississippi River.

Voucher specimen: **Clinton Co.:** dry-mesic slope N of Albany, 11 Apr 1998, *M. Gorton 98-147* (EKY); 21 Apr 1999, *M. Gorton 99-109* (EKY).

Carex oxylepis Torr. & Hook. var. **pubescens** J.K.Underwood (CYPERACEAE). Though *C. oxylepis* var. *oxylepis* is known from Kentucky (Medley 1993), this collection appears to be the first of *C. oxylepis* var. *pubescens* from the state. Additionally, the population documented by this record represents a portion of the northern range limit of this variety. This taxon appears to be rare; literature reports are from only one county in Alabama (Bryson et al. 1992), ten counties of Arkansas (Hyatt 1998), one county of Illinois (Basinger & Shimp 1999), one county of Mississippi (Bryson et al. 1992), and four counties of Tennessee (Chester et al. 1993).

Voucher specimen: **Clinton Co.:** mesic deciduous-juniper forest NE of Albany, 20 May 1999, *R. Naczi 7982* (DOV, EKY, KNK).

Carex roanensis F.J.Herm. (CYPERACEAE). This is the first record of this sedge from Kentucky. It was previously known from only a few populations in Georgia, North Carolina, Tennessee, Virginia, and West Virginia, mostly from high elevation sites (Wieboldt et. al 1998). It was found at several sites on Black Mountain, at elevations between 1100-1150 m, but these sites are threatened by strip mining activities. It has recently been added to the Kentucky list of rare plants as Endangered.

Voucher specimen: **Harlan Co.:** Black Mountain, wooded S-facing slopes above Razor Fork, 19 Aug 1998, *R. Jones and J. Metzmeier 8737b, 8757* (EKY).

Carex seorsa Howe (CYPERACEAE). These records add two counties to the two previously reported, Bath and Graves (Ousley & Risk 1998; McKinney et al. 2000). This species is most common on the Coastal Plain, and populations outside of that physiographic province are very few (Reznicek & Ball 1980). It is currently listed as a Special Concern taxon in Kentucky.

Voucher specimens: **Calloway Co.:** Blood River Embayment, 23 May 1989, *J. Grubbs 1383* (MUR). **Clinton Co.:** hardwood swamp NW of Albany, 22 May 1998, *Naczi 7175 & Ford* (DOV); 20 May 1999, *R. Naczi 7986* (KNK).

Eleocharis tuberculosa (Michx.) Roemer & Schultes (CYPERACEAE). This collection represents a state record for Kentucky. It ranges mostly on the Coastal Plain, and it is quite rare outside of that province (Svenson 1937), though it does occur nearby in Fentress County, Tennessee (Chester et al. 1993).

Voucher specimens: **Clinton Co.:** openings in hardwood swamp NW of Albany, 20 May 1999, *R. Naczi 8002* (DOV, EKY, KNK); 3 Aug 2000, *R. Naczi 8598 & M. Wessel* (DOV, EKY, KNK).

Gentiana andrewsii Griseb. (GENTIANACEAE). This collection is apparently the first documented record of this species for Kentucky. Browne and Athey (1992) cited specimens from the Mississippian Plateau and the Bluegrass regions, but these citations were apparently based on a specimen from Mammoth Cave (*J. Bruna s.n.*, 23 Oct 1965, EKY!), which has now been annotated by R. Jones

as *Gentiana saponaria* L., and on a specimen once housed at the University of Kentucky Agricultural Herbarium—this specimen was searched for but could not be located. The collection cited by Medley (1993) as a voucher for Kentucky, (*Short s.n.*, 1837, MICH!) lacks locality data. The "Lexington, Kentucky" pre-printed on the label was Short's residence at the time (Stafleu & Cowan 1985), and not the place where the plant was collected. Short's habit was to write the collection locality on the label, in the space above pre-printed information. Since his label lacks such an inscription, it must be regarded as of unknown provenance. Pringle (1967) cited no Kentucky specimens of *G. andrewsii*, and states that this Campbell County collection is the first he has seen for the state (J. Pringle, pers. comm.). The site of the collection is at or near the southern range limit for *G. andrewsii*, which is known from nearby southern Indiana and southern Ohio (Pringle 1967). At the Campbell County locality, the gentians were locally common in an open, wet-mesic, deciduous floodplain forest dominated by young *Acer rubrum* and *Quercus palustris*.

Voucher specimen: **Campbell Co.:** Silver Grove, floodplain of Ohio River, 13 Oct 1997, *R. Naczi 7059* (KNK), dupl. det. by James S. Pringle; 29 Sep 1998, *R. Naczi 7735* (KNK).

Vaccinium erythrocarpum Michx. (ERICACEAE). The mountain cranberry is restricted to the southern Appalachians, from West Virginia to Georgia, mostly above 1000 m. Medley (1993) reported a possible sterile specimen of this species collected from Harlan County (*L. Pounds 85-138*) deposited at the University of Tennessee Herbarium, but a recent search failed to locate any Kentucky collection (B. E. Wofford, pers. comm.). This fruiting specimen substantiates the presence of the species in Kentucky. The site, however, is likely to be destroyed by strip mining activities. It has recently been added to our state list of rare plants as Endangered.

Voucher specimen: **Harlan Co.:** S slope of Black Mountain, woodland edge along mining road toward Left Fork of Fugitte Creek, elevation 900 m, 14 Aug 1998, *R. L. Jones & J. Metzmeier 8639* (EKY).

Viburnum lantanoides Michx. (CAPRIFOLIACEAE). This is the first record of *Viburnum lantanoides* for Kentucky. Earlier reports were unsubstantiated or based on misidentifications (Weckman 1999). The species is common in some high elevation areas of the southern Appalachians, usually above 1000 m. It has been documented from several western Virginia counties, including contiguous Wise County (Harvill et al. 1986), but is not yet known from Tennessee counties adjacent to the Kentucky border (Chester et al. 1997). A single population of about 50 individuals was discovered in the Razor Fork streamhead, growing with *Betula alleghaniensis* and *Magnolia fraseri*. Persistence of this Kentucky population is threatened by potential valley fill associated with proposed strip mining on Black Mountain. It has recently been added to the Kentucky list of rare plants as Endangered.

Voucher specimen: **Harlan Co.:** Black Mountain, at head of Razor Fork, elevation 1050 m, 19 Aug 1998, *R. L. Jones & J. Metzmeier 8804* (EKY); 5 Sep 1998, *T. Weckman 4349* (EKY).

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NEW RECORDS IN ASTERACEAE FOR ALABAMA AND ARKANSAS

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Continuing study of Asteraceae brings to light additions to the Arkansas and Alabama floras.

Pluchea yucatanensis Nesom. When first described (Nesom 1989), *P. yucatanensis* was known in the USA from only one collection in Hancock Co., Mississippi. It is now recorded from four contiguous counties in Alabama (first report here) and Mississippi and appears to be an established element of the flora in that area of the Gulf Coast. Its larger range is in Central America (Belize) and Mexico (Veracruz, Campeche, and Quintana Roo).

Voucher specimens. **ALABAMA. Mobile Co.:** just N of jct. Co. Rd 59 and Ala. Hwy 188, sandy edge of salt marsh in slash pine, 15 Jul 1969, *Kral 35624* (VDB). **MISSISSIPPI. Hancock Co.:** S of Kiln, sandy area along Jordan River, coastal flatwoods, 26 Aug 1966, *Jones 9575* (NCU); S of Kiln, sandy, low area along Jordan River, edge of mixed woods with *Serenoa*, *Sabal*, *Nyssa*, *Taxodium*, 30 May 1967, *Jones 12656* (TEX); S of Kiln, low sandy soil along Jordan River, 6 Jul 1967, *Jones 14155* (NCU). **Harrison Co.:** SW of Wool Market, low sandy soil along Biloxi River, R 10W T 7S Sec 8, 23 Jul 1967, *Jones 14818* (GH). **Jackson Co.:** Ocean Springs P.O., low wet areas, 2 Jul 1952, *Demaree 32262* (BRIT-SMU, GH); E of Ocean Springs, near borrow pit on Hwy 90, 25 Jul 1966, *Deramus 548* (VDB); Ocean Springs, 30 Jul 1896, *Pollard 1129* (GH).

Pluchea yucatanensis is similar in habit and general appearance to *P. foetida* (L.) DC. and *P. rosea* Godfrey and has been misidentified as both. The rose-tinted phyllaries and florets are more similar to *P. rosea*, but the glabrous, slightly thickened, shiny leaves and glabrous phyllaries are unambiguous recognition characters for *P. yucatanensis*.

Pseudognaphalium luteoalbum (L.) Hilliard & Burtt. A recent report expanded the known range of this species into Texas and New Mexico (Nesom 2001). It probably should be expected in Oklahoma and other states eastward. It is already documented in Florida by many collections.

Voucher specimen. **ARKANSAS. Nevada Co.:** flat clear-cut woods along Co. Rd 221 E of Co. Rd 37, N of Missionary Grove Baptist Church, N of Prescott, 19 Aug 1999, *Thomas* and *Young 162,394* (TEX).

Symphyotrichum puniceum (L.) A. & D. Löve var. **scabricaule** (Shinners) Nesom. Variety *scabricaule* previously has been recorded from localities in Texas, Louisiana, and Mississippi (Nesom 1997).

Voucher specimen. **ALABAMA. Chambers Co.:** 1.9 mi NW of Penton, seepage area in granite outcrop area, 17 Oct 1969, *Kral 37887* (BRIT, VDB-5 sheets).

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The occurrence of *Symphyotrichum puniceum* in Alabama was documented by Mohr (1901), who noted that the only collection was by F.S. Earle from Auburn in Lee County in the east-central section of the state (immediately adjacent to Chambers County). Mohr noted that the plants grew in "swampy borders of woods" in "metamorphic hills" of the "mountain region." Both Alabama localities are at the southwestern extreme of the southward Appalachian extension of the range of *S. puniceum* through Georgia. Some of the distinctly montane Georgia populations are typical in morphology (var. *puniceum*) while others (e.g., Haralson Co., *Kral 77182*-VDB) show features of var. *scabricaule*, especially in reduction of the uppermost leaves. Prior to this report, var. *scabricaule* was considered a Gulf coastal plain endemic (Nesom 1997). Chambers and Lee counties are slightly north of the coastal plain (as marked by the boundary between Cretaceous and older Paleozoic formations, e.g., see Sorrie & Weakley 2001). Lee County, however, is included in four of the geographic patterns of coastal plain endemism shown Sorrie and Weakley.

Kartesz (1999) includes *Symphyotrichum puniceum* for Alabama as var. *puniceum*, but the morphology of the plants suggests that identification as var. *scabricaule* is more appropriate. The lower leaf surfaces are about the same color as the upper surfaces, without a reticulum of dark veins, the main veins of the upper leaf surfaces are shallowly impressed, giving a slightly rugose appearance, and the leaves of the capitulescence are markedly reduced in size compared to the lower.

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SIX NON-NATIVE SPECIES NEWLY DISCOVERED IN THE IOWA VASCULAR FLORA

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With the continuing invasion of indigenous floras by non-native elements, it is important to document early appearances of alien species. This paper focuses on six species that have appeared in the Iowa vascular flora in recent years. Two species were first noted in 1976 and 1981, the remainder in 2000. None of these species are included in the checklist of Iowa vascular plants by Eilers and Roosa (1994). Single populations of two species were first reported in Norris et al. (2001). This paper documents additional populations. Although these species are not widespread as yet in the state, there probably is no barrier to their spread. Most are weeds of ornamental plantings and are spread primarily via horticultural materials. Most previous studies of horticultural introductions have focused on the spread of woody landscape plants (Vincent & Cusick 1998). The present work concerns the incidental introduction of herbaceous species. One shrub discussed below, *Tamarix parviflora* DC., potentially is a serious pest species, however. Careful searching should yield additional Iowa populations of all six species.

Specimen citations are abbreviated and full details are available from the author.

Anethum graveolens L. (APIACEAE). Culinary dill is a sporadic waif in North America. Apparently, this is the first report of this herb in the Iowa flora.

Des Moines Co.: bank of Mississippi River, US Hwy. 34 bridge, Burlington, 15 Jul 2000, *Cusick 35548* (ISC, MICH).

Fatoua villosa (Thunb.) Nakai (MORACEAE). Mulberry-weed is an annual species from Asia which now is common throughout the southeastern United States. It typically grows in nurseries and amid ornamental plantings. It also is a common adventive in greenhouses. The Iowa population is a northwestern range extension from southern Missouri and central Ohio (Wunderlin 1997). In the north, *Fatoua villosa* is restricted to protected situations, such as walls and south-facing slopes. The climate at the Muscatine County site is moderated by the nearby Mississippi River. Mulberry-weed likely will be found at other places along the river in southern Iowa.

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Muscatine Co.: nursery on terrace of Mississippi River, St. Hwy. 22, Muscatine, 21 Jul 2000, *Cusick 35602* (ISC, MICH, MU, OSH).

Oxalis corniculata L. (OXALIDACEAE). This species is adventive from tropical America. In the southern U.S., it is widespread in ornamental plantings. It is common in greenhouses as well (Lourteig 1979). As with *Fatoua villosa*, it apparently spreads as a contaminant with potted ornamentals, based upon the author's personal observations of nursery material.

Black Hawk Co.: lawn, Gilchrist Hall, University of Northern Iowa campus, 1 Apr 1981, *T. Lammers 4028* (ISC). **Muscatine Co.:** nursery on terrace of Mississippi River, St. Hwy. 22, Muscatine, 21 Jul 2000, *Cusick 35603* (ISC).

Sagina procumbens L. (CARYOPHYLLACEAE). European pearlwort was first reported in Iowa from Story County where it was discovered in 2000 (Norris et al. 2001). It is common throughout the northeastern and northwestern U.S., but sporadic in Midwestern states. This perennial species typically grows in crevices in walls and sidewalks and as a weed in ornamental plantings. The similar annual, *Sagina decumbens* (Ell.) T.&G., grows in comparable situations and occurs near Iowa in northcentral Illinois (Crow 1978).

Cerro Gordo Co.: garden store, 4th St. SW & S Polk Ave., Mason City, 19 Jul 2000, *Cusick 35588* (ISC); **Muscatine Co.:** nursery on terrace of Mississippi River, St. Hwy. 22, Muscatine, 21 Jul 2000, *Cusick 35601* (ISC).

Tamarix parviflora DC. (TAMARICACEAE). Salt cedar is a widespread invasive species of riparian corridors throughout the western United States. It is a serious pest, often forming a monoculture that reduces natural biodiversity (Weisenborn 1996). The plants are isolated at the Des Moines County station, with no planted material nearby. Its presence in the Iowa flora should be closely monitored. Extirpation of the shrubs at the single known site probably is warranted.

Des Moines Co.: two tall shrubs, edge of pond, Sullivan Slough Rd., S of Burlington, 15 Jul 2000, *Cusick 35555* (ISC, MICH).

Viola arvensis Murray (VIOLACEAE). A single previous collection of European field pansy from Story County, Iowa in 1998 has been reported (Norris et al. 2001). Unlike most violets, this is an annual species that may bloom in any month of the growing season.

Cerro Gordo Co.: nursery, St. Hwy . 122, Mason City, 17 Jul 2000, *Cusick 35585* (ISC). **Des Moines Co.:** flowerbed, 1326 Griswold St, Burlington, 4 Jul 1976, *T. Lammers 876* (ISC).

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Books Received/Notices

Annotations and comments by the Editor

Systematics/Monographs/Floras/Guides

Bruce G. Galdwin, Steve boyd, Barbara J. Ertter, Robert W. Patteson, Thomas J. Rosatti, and Dieter H. Wilken (eds), Margriet Wetherwax (managing ed). 2002. **The Jepson Desert Manual. Vascular Plants of Southeastern Califonria.** (ISBN 0-520-22775-1, pbk.). University of California Press, Berkeley, CA 94720, U.S.A. (Orders: California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A., 609-883-1759, 609-883-7413 fax, www.ucpress.edu). $35.00, 624 pp., 128 color photos, many line drawings, 7" × 10".

Key Words: Systematics, botany, identification, keys, natural history, California, southeastern California, Mojave Desert, Sonoran Desert, southern Great Basin, White Mountains, desert plants, vascular plants.

The color photo section is quite a nice addition since its "mother," *The Jepson Manual*, did not include color photos. California is big enough for good regional floras.

Peter Lesica. 2002. **A Flora of Glacier National Park.** (ISBN 0-87071-538-0, pbk.). Oregon State University Press, 101 Waldo Hall, Corvallis, OR 97331-6407, U.S.A. (Orders: 800-426-3797, 541-737-3170 fax, OSU.Press@orst.edu, osu.orst.edu/dept/press/osupress.htm). $32.95, 480 pp., 8-page color insert, 60 color photos, 351 line drawings, 6" × 9".

Key Words: Systematics, flora, field guide, keys, descriptions, habitats, geographical range, taxonomy, ethnobotanical uses, climate, geology, early botanical exploration, plant geography, introduced species, Rocky Mountains.

David H. Engel and Suchart Phummal. 2002. **A Field Guide to Tropical Plants of Asia.** (ISBN 0-88192-542-X, pbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $19.95, 280 pp., app.rox. 390 color photos, 8 figures, 6" × 9".

Key Words: Asia, tropical plants, field guide, flora, identification, descriptions, local names, over 300 species.

The flora is broken down by trees, shrubs, vines, groundcovers, and bedding plants. Under each category, the plants are listed by flower, foliage and fruit

NOTEWORTHY VASCULAR PLANTS FROM ARKANSAS. II

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ABSTRACT

The authors provide a list of 41 additions, reinstatements, and significant range extensions for the flora of Arkansas. *Alternanthera paronychioides, Bowlesia incana, Eleocharis montevidensis, Hypoxis curtissii, Nandina domestica, Polygonum setaceum,* and *Trifolium lappaceum* are reported as new and persistent elements, while *Ipomea ×leucantha, Mirabilis jalapa, Najas minor,* and *Veronica polita* are reinstated to the state flora. A number of alien weeds –*Cynoglossum zeylanicum, Eleusine tristachya, Euphorbia hirta, Scoparia dulcis, Tragopogon pratensis, Trifolium nigrescens, Verbena montevidensis*– are noticed and documented for the first time, however, their persistence is not known

RESUMEN

Los autores proporcionan una lista donde se enumeran 41 adiciones, restablecimientos, y extensiones de área significativas para la flora de Arkansas. *Alternanthera paronychioides, Bowlesia incana, Eleocharis montevidensis, Hypoxis curtissii, Nandina domestica, Polygonum setaceum,* y *Trifolium lappaceum* son citadas como componentes nuevos y persistentes del área, mientras que *Ipomea X leucantha, Mirabilis jalapa, Najas minor,* y *Veronica polita* son una rehabilitación paraa la flora del estado. Un número de malas hierbas de origen alóctono—*Cynoglossum zeylanicum, Eleusine tristachya, Euphorbia hirta, Scoparia dulcis, Tragopogon pratensis, Trifolium nigrescens, Verbena montevidensis* – son mencionadas y documentadas por primera vez, sin embargo, su persistencia no es conocida.

The authors provide a list of 41 taxa representing additions and reinstatements to the Arkansas flora as well as noteworthy range extensions within the state. Herbarium abbreviations are taken from Holmgren et al. (1990).

AMARANTHACEAE

Alternanthera paronychioides St. Hilaire. Thomas discovered large populations of this prostrate chaff-flower around the edge of borrow pits inside the Mississippi River levee, in Chicot and Lincoln counties, in August and September, 2000. Duplicate specimens were confirmed by Kenneth R. Robertson of the Illinois Natural History Survey in Champaign.

Voucher specimens: **Chicot Co.:** *Thomas 166,893 & 167,194* (NLU, UAM). **Lincoln Co.:** *Thomas & Sundell 167,417* (NLU, UAM).

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APIACEAE

Bowlesia incana Ruiz and Pavon is a decumbent annual of low woods, clearings, lawns, and other moist, weedy places, occurring sporadically in Louisiana and eastern Texas (Thomas and Allen 1996, Diggs et al. 1999). We record its first appearance in Arkansas from Chicot County in the southeast corner of the state, along a road bank as well as in alluvial woods along Indian Creek south of Eudora.

Voucher specimens: **Chicot Co.:** *Thomas 164,552* (NLU), *164,589* (NLU, UAM).

Sanicula smallii Bickn. Smith (1988) documents this cryptic black snakeroot from two counties in the Ozark Mountains. We add collections from the Ouachita Mountains and the Coastal Plain and suggest that the species might be undercollected in Arkansas. It is distinguished in the field from the widespread *S. canadensis* by rather subtle characters: sessile, slightly larger fruits and semi-succulent leaves. (The tuberous, thickened roots are only helpful *after* the plant has been recognized.) In addition, in at least one of our populations the two woodland species were mixed, with *S. canadensis* much the more common.

Voucher specimens: **Bradley Co.:** *Leslie 438B* (NLU) **Lafayette Co.:** *Sundell, Thomas, & Amason 12,300* (UAM). **Montgomery Co.:** *E. & J. Sundell 11,826* (UAM). **Ouachita Co.:** *Thomas & Doffitt 163,219* (NLU). **Union Co.:** *Thomas 104,816* (NLU).

ASTERACEAE

Hypochoeris glabra L. Smith (1988) documents smooth cat's ear, a European weed, from two counties in south Arkansas. We supply voucher specimens for his two *Atlas* reports ("R" for Ashley and Bradley counties) and add eight additional counties to the record.

Voucher specimens: **Ashley Co.:** *Hooks 253* (NLU). **Bradley Co.:** *Leslie 1756* (NLU). **Cleveland Co.:** *Thomas 135,389* (NLU). **Conway Co.:** *Edwin B. Smith 4032* (UAM). **Lafayette Co.:** *Thomas, Sundell & Amason 127,585* (NLU). **Miller Co.:** *Thomas 160,883* (NLU). **Nevada Co.:** *Thomas & Slaughter 104,341* (NLU, UAM). **Ouachita Co.:** *Thomas & Doffitt 169,040* (NLU). **Sevier Co.:** *Thomas, Sundell & Amason 166,304* (NLU). **Union Co.:** *Sundell, Thomas, & Amason 8210* (UAM).

Marshallia caespitosa Nutt. In May, 1999, lavender-flowered Barbara's buttons was known in Arkansas from eleven occurrences recorded in the Arkansas Natural Heritage Commission data base. During a field study commissioned by the Heritage Commission, ten of those populations, scattered in glades and open, riparian communities in the Ozark and Ouachita highlands, were relocated and several voucher specimens made.

Voucher specimens (**M. caespitosa** Nutt. var. **caespitosa**): **Carroll Co.:** *Sundell & Wallace 12,617* (UAM). **Madison Co.:** *Dalton & Dow 1a* (UARK). **Montgomery Co.:** *Sundell & Wallace 12,576* (UAM, UARK), *Sundell & Wallace 12,585* (UAM).

Voucher specimens (**M. caespitosa** Nutt. var. **signata** Beadle & Boynt): **Perry Co.:** *Thomas 139,690* (NLU). **Pulaski Co.:** *Sundell & Wallace 12,574* (UAM).

Tragopogon pratensis L. lacks the inflated peduncles of *T. dubius*, the common

goat's beard of the roadsides of north Arkansas. *T. pratensis* is widely established in the northern U.S., extending south to Tennessee (Cronquist 1980), but has not previously been reported from Arkansas.

Voucher specimen: **Lawrence Co.:** *Sundell 10,417* (UAM).

BERBERIDACEAE

Nandina domestica Thunb. A candidate for the most popular ornamental shrub in south Arkansas, "heavenly bamboo" is not documented as a naturalized species of the state flora. It both persists after cultivation and escapes (presumably dispersed by birds) to open areas and wood margins where it is sufficiently competitive to reach reproductive maturity.

Voucher specimen: **Ashley Co.:** *Sundell & McDonald 7619* (UAM).

BORAGINACEAE

Cynoglossum zeylanicum (Hornem.) Thunb. ex Lehm. This previously unreported hound's tongue grew as an aggressive pasture weed in Sevier County in the foothills of the Ouachita Mountains. In addition, a second collection is reported from sandy soil in Union County. The species is known in the Southeast from Texas (Jones et al. 1997; Diggs et al. 1999) and Louisiana (from Claiborne and Union parishes along the Arkansas border) (Thomas and Allen 1996). The burs (mericarps) are 3-4 mm long, smaller than those of *C. virginianum* and *C. officinale*.

Voucher specimens: **Sevier Co.:** *Tyler s.n.* (NLU, UAM, UARK). Union **Co.:** *Thomas 116,853* (NLU).

CAMPANULACEAE

Wahlenbergia marginata (Thunb.) DC. was first reported for Arkansas (Thomas et al. 1991) from a road bank in Union County. The species was rediscovered in 2000 along railroad tracks on the south side of Camden.

Voucher specimen: **Ouachita Co.:** *Thomas & Doffitt 167,860* (NLU).

COMMELINACEAE

Murdannia keisak (Hassk.) Hand.-Mazz. We add two more documented occurrences of this easily overlooked, rambling, succulent-stemmed herb, previously known in Arkansas from two localities (Sundell et al. 1999).

Voucher specimens: **Faulkner Co.:** *Thomas & Sundell 164,429* (NLU). **Ouachita Co.:** *Thomas & Doffitt 63,274* (NLU).

CONVOLVULACEAE

Ipomea × **leucantha** Jacq. The pink bindweed treated by Fernald (1950) and Smith (1988) as *Ipomoea lacunosa* L. forma *purpurata* Fern. is recognized by Austin (1978) as a natural hybrid between *I. lacunosa* and *I. trichocarpa* Ell. (*I. cordatotriloba* Dennst.). We add a third county record to the two cited in Smith, all three in the Mississippi Delta of southeast Arkansas.

Voucher specimen: **Drew Co.:** *Sundell & Wiley 8686* (UAM).

Ipomea cordatotriloba Dennst. We add three county records, from agricultural sites, to the documented Arkansas distribution (Lafayette County, Smith 1988) of this weedy purple morning glory.

Voucher specimens: **Crittenden Co.:** *Thomas 113,405* (NLU, UAM). **Jefferson Co.:** *Thomas 147,277* (NLU, UAM). **Ouachita Co.:** *Thomas & Doffitt 167,857* (NLU)

CUCURBITACEAE

Citrullus lanatus (Thunb.) Matsum. & Nikai var. **lanatus**. Six collections from southeast Arkansas document the status of watermelon at least as a waif in the state flora.

Voucher specimens: **Bradley Co.:** *Thomas & Amason 141,965* (NLU, UAM). **Calhoun Co.:** *Sundell et al. 12,536* (UAM). **Chicot Co.:** *Thomas 164,414* (NLU). **Lincoln Co.:** *Thomas & Sundell 167,480* (NLU). **Ouachita Co.:** *Thomas & Doffitt 167,999* (NLU). **Union Co.:** *Thomas 111,808* (NLU).

CYPERACEAE

Eleocharis montevidensis Kunth is known from northern Louisiana (Thomas and Allen 1993) and included in Smith's *Keys to the flora of Arkansas* (1994) as a possible addition to the state flora. We document its occurrence with a collection from Lake June in Stamps, in southwest Arkansas.

Voucher specimens: **Lafayette Co.:** *Sundell, Thomas, & Amason 12,273* (UAM, UARK).

Websteria confervoides (Poir.) Hooper (*Scirpus confervoides* Poir. in Lam.). Walker and Campbell (1997) first reported this submersed, aquatic sedge in Arkansas from a Jefferson County collection. We add two collections from Union County. The species is rather broadly distributed in Louisiana (twelve parishes, four along the Arkansas border; Thomas & Allen 1993) and probably more widespread in southern Arkansas than we know.

Voucher specimens: **Jefferson Co.:** *Walker 1206961* (UAM). **Union Co.:** *Thomas & Amason 143,312* (NLU, UAM); *Crossland s.n.* (UAM).

ELATINACEAE

Bergia texana (Hook.) Seub. ex Walp. Collections from the banks of the Red River and the Arkansas River represent the third and fourth confirmed occurrences of this species in Arkansas.

Voucher specimens: **Lafayette Co.:** *Thomas 120,776* (NLU). **Lincoln Co.:** *Thomas & Sundell 167,421* (NLU).

EUPHORBIACEAE

Caperonia palustris (L.) St.-Hil. is a wetland weed of tropical American origin known to occur in the U.S. in south Florida, Louisiana and southeast Texas (Godfrey & Wooten 1981). Smith (1988) has seen specimens from three Mississippi Delta counties in southeast Arkansas to which we add a fourth, where plants were collected from a rice field.

Voucher specimen: **Jefferson Co.:** *Brady Harmon s.n.* (UAM).

Euphorbia hirta L. was found growing as a weed in a flower bed in southeast

Arkansas, its stems ascending above a mat of *E. maculata* L. The species is previously unreported for Arkansas.

Voucher specimens: **Bradley Co.:** *Sundell 15,130* (BRIT-SMU, NLU, NY, UAM, UARK).

Phyllanthus tenellus Roxb. was reported (Sundell et al. 1999) as a tentative addition to the Arkansas flora from weeds escaping their containers at a Drew County nursery. We add a second locality, Ellis's Nursery in Fountain Hill, Ashley County, where again plants arriving as weeds in containers from Louisiana and Texas have spread aggressively throughout the nursery's grounds and greenhouses.

Voucher specimens: **Ashley Co.:** *E. & M. Sundell 13,039* (BRIT-SMU, NLU, UAM, UARK).

FABACEAE

Lathyrus aphaca L. Previously documented only from Miller County in southwest Arkansas (Smith 1988), this unique Eurasian peavine (the stipules functionally replace the leaflets) was collected on a roadbank in central Arkansas. Established on the West Coast (Isely 1998), the species is apparently taking hold in the Southeast as well. It was first reported for the region from Tennessee in 1972 (Beardsley and Browne) and recently from Texas in 1997 (Jones and Reznicek). Thomas and Allen (1998) map collections from four Louisiana parishes.

Voucher specimens: **Conway Co.:** *Thomas & Amason 135,545* (NLU, UAM).

Medicago minima (L.) Bartal. A fourth Arkansas county is added to the record for little bur clover.

Voucher specimen: **Washington Co.:** *Sundell, Thomas & Amason 14,155* (UAM).

Trifolium lappaceum L. Lappa clover is a distinctive Old World clover naturalized on the Gulf Coast from Alabama to east Texas (Isely 1990). It is reported here as new to Arkansas from Grandview Prairie, near Columbus, in Hempstead County. The Arkansas Game and Fish Commission is successfully restoring this blackland prairie site to its original vegetation. Plants were collected in a restored area dominated by compass plant (*Silphium laciniatum*) and purple and white prairie clovers (*Dalea purpurea, D. candida*)—a spring alien among summer natives.

Voucher specimen: **Hempstead Co.:** *Sundell 12,371* (UAM).

Trifolium nigrescens Viviani. Ball clover is a sprawling, weedy annual from southern Europe and southwest Asia recently introduced into the southeastern United States (Isely 1998). Two collections from ruderal sites document its occurrence and extend its range as a naturalized species in Arkansas. Ball clover is easily mistaken for alsike clover (*T. hybridum*) but distinguished by the smaller umbels and scarious (rather than membranous), more subulate stipules.

Voucher specimens: **Bradley Co.:** *Thomas & Leslie 92,208 & 974* (NLU, UAM). **Drew Co.:** *Sundell 13,172* (NLU, UAM, UARK).

HYPERICACEAE

Hypericum nudiflorum Michx. Smith (1988) documents this shrubby St. John's wort from Drew County in southeast Arkansas. We here confirm his report (no voucher specimen was seen) of the species' presence in Ashley County with two collections, and we document two additional counties.

Voucher specimens: **Ashley Co.:** *Sundell, Hartrick, & Etheridge 7234* (UAM); *Thomas 97,093* (NLU). **Poinsett Co.:** *Thomas 10,314* (NLU). **Union Co.:** *Thomas 107,901* (NLU).

LAMIACEAE

Melissa officinalis L. Smith (1988) records lemon balm as an adventive from several Ozark and Ouachita Mountain counties. We here make note of a collection from the Coastal Plain.

Voucher specimen: **Grant Co.:** *Thomas & Sundell 164,430* (NLU).

LILIACEAE

Hypoxis curtissii J. Rose (*H. leptocarpa* (Engelm. & Gray) Small) grows in swamps and floodplain forests of the Atlantic and Gulf coastal plains (Godfrey and Wooten 1979). We record it as new to the state from Bodcaw Creek, in southwest Arkansas, where it occurred with *Styrax americana, Planera aquatica, Fraxinus caroliniana,* and *Crataegus opaca* under an overstory of *Quercus lyrata.*

Voucher specimens: **Lafayette Co.:** *Sundell, Thomas, & Amason 12,342* (UAM, UARK).

Lycoris radiata (L'Her.) Herb. With its leaves appearing in autumn after the flowers, red spider lily is nicely adapted to the annual lawn mowing rhythms of most homeowners and has become a common lawn weed in southeast Arkansas as well as an occasional waif in other disturbed sites. We note its presence in the Arkansas flora with three collections.

Voucher specimens: **Chicot Co.:** *Thomas 163,666* (NLU). **Drew Co.:** *Sundell 9,239* (UAM). **Ouachita Co.:** *Thomas & Doffitt 167,947* (NLU)

NAJADACEAE

Najas minor Allioni. Northeast Arkansas is included by Haynes (1979) within the range of this distinctive Old World naiad, but neither localities nor specimens are cited. Thomforde's collection from the shallow margin of a goldfish pond in central Arkansas (21 August 2000) reconfirms the species' occurrence in the state. Recent north Louisiana collections unknown to Haynes (Thomas & Allen 1993) suggest that *Najas minor,* which apparently invaded North America around 1930, may still be extending its range to the west and is likely more widespread in Arkansas than we know.

Voucher specimen: **Lonoke Co.:** *Thomforde s.n.* (UAM)

NYCTAGINACEAE

Mirabilis jalapa L. Reported by Leslie (1986) but excluded by Smith (1988) as a naturalized element in Arkansas, four o'clock is reinstated with roadside col-

lections from the Ozark Highlands and the Coastal Plain. At none of the sites did plants appear to be merely persisting after cultivation. Four o'clock is mapped by Thomas and Allen (1998) from six of eight of Louisiana's northern tier of parishes.

Voucher specimens: **Bradley Co.:** *Thomas & Amason 142,066* (NLU, UAM). **Newton Co.:** *Thompson 685* (NLU). **Union Co.:** *Thomas & Amason 111,373* (NLU, UAM).

POACEAE

Andropogon ischaemum L. var. **songaricus** Rupr. ex Fisch. & Mey. (*Bothriochloa ischaemum* (L.) Keng var. *songaricus* (Rupr.) Celerier & Harlan), an intrusive, pernicious Eurasian bluestem, is common to the roadsides and pastures of the southern Great Plains (Gould 1975, Great Plains Flora Association 1986). It has become widespread in Louisiana (Thomas & Allen 1993) and an occasional weed east to Florida (Wunderlin 1998). We add three counties to its documented occurrence (Franklin Co.) in Arkansas.

Voucher specimens: **Drew Co.:** *Sundell 15,128* (NLU, NY, UAM, UARK). **Miller Co.:** *Miesner s.n.* (UAM). **Ouachita** Co. *Thomas & Doffitt 168,023* (NLU).

Eleusine tristachya (Lam.) Lam., a diminutive goosegrass of African origin, is known as a waif in North America from a few scattered localities (Hitchcock and Chase 1950, Kucera 1998) and is apparently naturalized in California (Smith 1993). We report it as a new record from northeast Arkansas, where it occurred as a lawn weed.

Voucher specimen: **Independence Co.:** *S.D. Carter s.n.* (UAM).

POLYGONACEAE

Fagopyrum esculentum Moench. Buckwheat spreads easily from cultivation to waste places but seldom persists (Great Plains Flora Association 1986, Steyermark 1963). Collections from a small population at the edge of a campus parking lot mark the species' first documented occurrence as a waif in Arkansas.

Voucher specimens: **Drew Co.:** *Sundell 12,567* (UAM, UARK).

Polygonum setaceum Baldwin. Godfrey and Wooton (1981) include Arkansas within the range of this widespread smartweed, and Smith (1988) made note of the species as a possible addition to the state flora based on its occurrence in several Louisiana parishes along Arkansas' southern border (MacRoberts 1988). We confirm its presence with voucher specimens from three counties.

Voucher specimens: **Chicot Co.:** *Thomas 163,358* (NLU). **Hot Spring Co.:** *Sundell & Crank 10,733* (UAM). **Union Co.:** *Thomas 112,374* (NLU).

RUBIACEAE

Diodia dasycephala C.&S. Especially in the field, "perennial poorjoe" so closely resembles *Spermacoce glabra* (rather than either of the common, congeneric

buttonweeds, *D. teres* and *D. virginiana*) that it has perhaps been overlooked and misidentified as often as any taxon in southern Arkansas. The two can be distinguished vegetatively. Leaves of the *Diodia* are shorter and dry greener; those of the *Spermacoce* are more prominently veined beneath. *Spermacoce glabra* bears numerous, whitish scalelike hairs at the stipular sheath summit beneath and between the bristles while *D. dasycephala* possesses a (more or less) prominent vein that traverses the broader summit of the glabrous stipular sheath just below its bristle-bearing margin. *Diodia dasycephala* is documented from six parishes in north Louisiana (Thomas & Allen 1998) and two counties in southeast Arkansas (Smith 1988). We add three more counties to the record, one from central Arkansas.

Voucher specimens: **Chicot Co.:** *Thomas 164,170* (NLU). **Faulkner Co.:** *Sundell & Thomas 15,954* (NY, UAM, UARK). **Lafayette Co.:** *Thomas, Sundell, & Amason 156,442* (NLU).

SCROPHULARIACEAE

Lindernia crustacea (L.) F. von Muell. is a wetland species, originally from southern Asia, that occurs sporadically in the coastal plain of the Southeast (Godfrey & Wooten 1981). Our collection represents the second documented occurrence in Arkansas.

Voucher specimen: **Pulaski Co.:** *Sundell 12,437* (UAM).

Scoparia dulcis L. Thomas and Amason collected this tropical American weed in a clearcut. It is known regionally from the Gulf Coast states (Correll & Johnston 1970) but unreported for Arkansas.

Voucher specimens: **Cleveland Co.:** *Thomas & Amason 158,319* (NLU, UAM).

Veronica hederifolia L. is confirmed by Smith (1988) for two northwest Arkansas counties. We add four more counties to the record of this relatively distinctive speedwell.

Voucher specimens: **Chicot Co.:** *Thomas 164,620* (NLU). **Mississippi Co.:** *Barbee 24* (UAM). **Pulaski Co.:** *Burgess & Bernstein 001* (UAM). **Saline Co.:** *Thomas & Amason 148,563 (NLU).*

Veronica polita Fries appears sufficiently distinct from *V. agrestis* to be recognized as a separate species. Specimens seen by Smith (especially at UARK), who merges the two in the Arkansas *Atlas* (1988), should probably be reexamined for additional material of the former species. We document the presence of *V. polita* in Arkansas from four counties.

Voucher specimens: **Baxter Co.:** *Hyatt 1063.03* (UAM). **Drew Co.:** *Sundell 10,755* (UAM). **Garland Co.:** *Demaree 59,995* (NLU). **Washington Co.:** *Sundell 12,263* (UAM).

VERBENACEAE

Verbena montevidensis Spreng. Thomas and Allen (1998) record this slender vervain from three parishes in central and eastern Louisiana. Four collections from south Arkansas suggest that it may have become established in this state as well.

Voucher specimens: **Ashley Co.:** *Thomas and Hooks 92,761* (NLU, UAM). **Bradley Co.:** *Thomas 90,519* (NLU). **Chicot Co.:** *Thomas 166,906* (NLU). **Union Co.:** *Thomas & Amason 111,853* (NLU).

ZANNICHELLIACEAE

Zannichellia palustris L. Horned pondweed is documented from three counties in the Ozark Plateau of northeast Arkansas (Smith 1988). Two collections of the submersed aquatic from central and southwest Arkansas extend its range to the Mississippi River Alluvial Plain and West Gulf Coastal Plain.

Voucher specimens: **Howard Co.:** *Lawson 2117* (NLU). **Lonoke Co.:** *Thomforde s.n.* (UAM).

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COMMELINA BENGHALENSIS (COMMELINACEAE) NEW TO NORTH CAROLINA AND AN UPDATED KEY TO CAROLINA CONGENERS

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ABSTRACT

A population of the federal noxious weed *Commelina benghalensis* L. (Commelinaceae) was recently identified in a soybean field in North Carolina. Voucher specimens are cited and an updated key to *Commelina* in the Carolinas is presented.

RESUMEN

Se identifica una población de la hierba nociva federal *Commelina benghalensis* L. (Commelinaceae) en un campo de semilla de soja en Carolina del Norte. Citamos especímenes y presentamos una clave nueva para *Commelina* en las Carolinas.

A common paleotropical weed, *Commelina benghalensis* L. (Tropical spiderwort, Benghal dayflower) has been previously collected in the southeastern United States only in Florida, Georgia, and Louisiana (Faden 1993; Thomas & Allen 1993). The taxon has not been reported for North Carolina by Radford et al. (1968), Kral (1981), or Faden (1993, 2000). Federally listed as a noxious weed in 1983 (Lasseigne 1983), *C. benghalensis* has primarily been found in citrus plantations, fields, yards, and other cultivated and disturbed sites in the southeast as far north as Georgia, as well as in California (Faden 1993). During a field survey, a population of this weed was identified in a soybean field in Goldsboro, Wayne County, in the Coastal Plain of North Carolina. The infestation occurs over an area of less than 2 ha, north of SR 1008 and near the Southern Railway. The density is quite high at the edges of the crop plots and lower in neighboring (intensively managed) cotton and soybean plots. The weed was first noticed about three years ago, but was thought to be a different species (*Commelina caroliniana* Walter occurs in a neighboring field). Representative material was prepared for deposit at NCSC, US, and USCH in Oct 2001.

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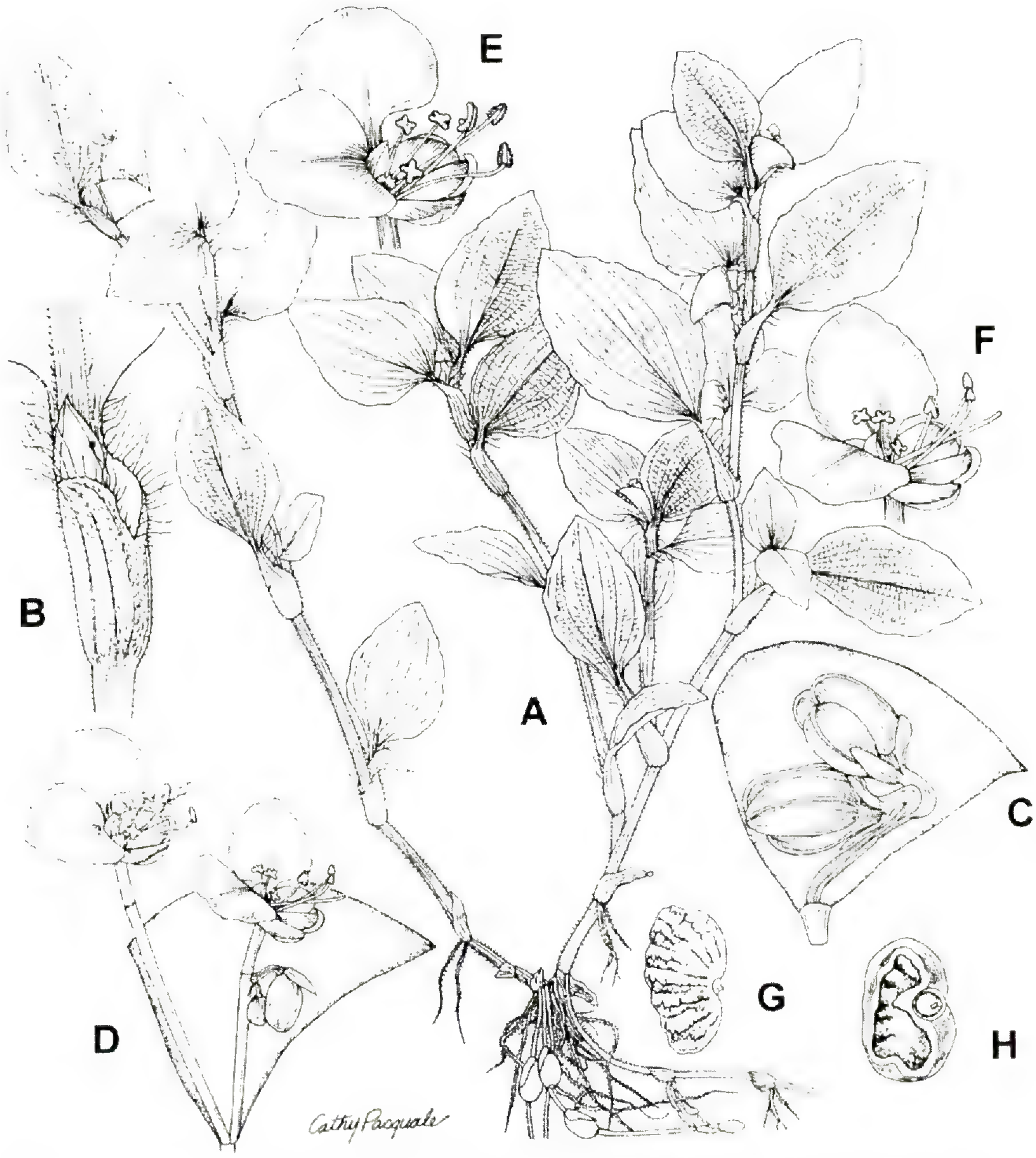


FIG. 1. *Commelina benghalensis* L. A, Whole plant, showing above ground and below ground inflorescence; B, Leaf sheath; C, Dissection of spathe with buds; D, Dissection of spathe, showing position of flowers; E, Imperfect, staminate flower; F, Perfect flower; G, seed from below ground fruit; H, Dissection of seed from above ground fruit. A-B based on *Tsiang 2498* (NY); C-H based on *Seydel 203* (MO). Illustration by Cathy Pasquale, courtesy of the U.S. Dept. Agric., Animal and Plant Health Inspection Service.

Voucher specimens: **U.S.A. NORTH CAROLINA. Wayne Co.:** Goldsboro, in a soybean field, 35.397 deg N, 78.046 deg W, 27 Sep 2001, *Burton, Hoyle, and Mendoza s.n.* (NCSC, US, USCH).

Commelina benghalensis L. (Fig. 1) can be distinguished from its southeastern congenerics by the often clustered, infundibuliform spathes, the relatively broad leaves, often bearing reddish hairs on the sheath apex, and the basally-borne,

sometimes subterranean cleistogamous flowers in addition to chasmogamous flowers. An updated key, largely adapted from Faden (2000) follows:

KEY TO *COMMELINA* IN THE CAROLINAS

1. Spathes with margins connate basally.
   2. Roots stout; leaf sheaths auriculate apically; proximate petal white, minute; locules all 1-seeded _____ **Commelina erecta** L.
   2. Roots thin; leaf sheaths not auriculate; proximate petal blue to lilac or lavender, conspicuous; some locules 2-seeded.
      3. Perennial with erect to ascending stems; lamina lanceolate-elliptic to lanceolate oblong, the apex acuminate; spathes 1.5–3.5 cm long; subterranean, cleistogamous flowers absent _____ **Commelina virginica** L.
      3. Annual with ascending to decumbent or occasionally scrambling stems; lamina ovate to lanceolate-elliptic, the apex rounded, obtuse, or acute; spathes 0.5–2 cm long; subterranean, cleistogamous flowers usually present _____ **Commelina benghalensis** L.
1. Spathes with margins free to base.
   4. Spathes typically discolored whitish or pale green near peduncle with contrasting, darker green veins; proximal petal whitish or paler than the others; capsules 2 locular; seeds rugose pitted-reticulate _____ **Commelina communis** L.
   4. Spathes uniformly colored, without contrasting veins; proximal petal essentially colored as the others; capsules 3-locular; seeds reticulate or smooth to somewhat alveolate.
      5. Spathes typically distinctly falcate; distal cyme in larger spathes usually well-developed, 1-several-flowered; seeds reticulate _____ **Commelina diffusa** Burman f.
      5. Spathes not falcate to only slightly so; distal cyme in larger spathes usually vestigial (rarely well-developed, 1-flowered); seeds smooth to somewhat alveolate _____ **Commelina caroliniana** Walter

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AGROSTIS AVENACEA (POACEAE: POOIDEAE): FIRST RECORD FOR THE MEXICAN FLORA

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ABSTRACT

Agrostis avenacea J.F. Gmel. is reported from temporary and permanent ponds of the region of Huimilpan and Amealco of the state of Queretaro, Mexico. Previously, it was only known from Australia, south Africa, Argentina, Chile, United State of America, the Hawaiian Islands and recently from Costa Rica. Diagnostic morphological and anatomical characters and illustrations are provided, and collection data and voucher specimens are cited.

RESUMEN

Agrostis avenacea J.F. Gmel. se cita de charcos temporales y permanentes de la región de Huimilpan y Amealco en el estado de Querétaro, México. Anteriormente sólo se conocía de Australia, sur de África, Argentina, Chile, Estados Unidos de América, Islas Hawai y recientemente de Costa Rica. Se proporcionan caracteres morfológicos y anatómicos diagnósticos e ilustraciones y se citan los datos de las colectas y especímenes examinados.

INTRODUCTION

Agrostis is a genus of grasses that was described by J.F. Gmelin in 1791. The genus is included in the Aveneae tribe and Alopecurinae subtribe (Pohl & Davidse 1994; Valdés-Reyna & Dávila-Aranda 1995). As presently circumscribed, the genus includes about 125–220 species (Acosta-Castellanos 1990; Beetle 1983; Clayton & Renvoize 1986; McVaugh 1983; Watson & Dallwitz 1992) which grow in temperate and cold regions from both hemispheres. In the tropics, they are mostly restricted to the high altitude mountains. Currently, the most recent list of species for Mexico (Espejo-Serna et al. 2000) shows that 23 species are registered for Mexico. While conducting an aquatic flora project of the Queretaro state Mahinda Martínez made a collection of subaquatic grasses from the Huimilpan and Amealco municipalities that proved to be *Agrostis avenacea* J.F. Gmel. This collection represents the first record of *A. avenacea* from Mexico and increases the number of species to 24.

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Deyeuxia forsteri Kunth, Revis. Gramin. 1:77. 1829.

Lachnagrostis willdenowii Trin., Gram. Unifl. Sesguifl. 217. 1824. *Calamagrostis willdenowii* (Trin.) Steud., Syn. Pl. Glumac. 1:192. 1854.

Plants annual, cespitose. Culms erect, thin, breakable, 20–60 cm tall, 1–2 mm broad. Leaf blade flat, 5–20 cm long, 1–3 mm broad. Ligule 2–5 mm long. Panicle open, lax, 15–30 cm long; branches thin, slender, inferiors as longer as inflorescence axis, spikelets on the tips of the branches. Glumes acute, 2–5 mm long, 1-nerved, scabrous on the keel. Lemma membranous, pilose, 1.4–1.6 mm long, 5-nerved, with a mid-dorsal once-geniculate awn. Palea membranous, 1.1–1.3 mm long, nearly as long as lemma, 2-nerved, tip bifid, callus pubescent. Chromosome number: 2n = 28. (Fig. 1A–F)

Habitat.—*Agrostis avenacea* grows on dry to moist soils, with abundant clay and from 15 to 2350 m in elevation. In Mexico, it is grows around small streams, temporary and permanent ponds, and at sites at 2280–2350 m in elevation. it is found as a member of the subaquatic vegetation (Fig 2B).

Distribution.—This species is native to Australia (Canberra, New South Wales, Queensland and Tasmania) and New Zealand. In the Missouri Botanical Garden's herbarium and VAST nomenclatural database (W^3 TROPICOS) (www.mobot.org), there are records of its introduction in South Africa, Argentina (Buenos Aires, depression of El Salado, Entre Ríos and Santa Fé) and Chile (Isla de Pascua) (Nicora & Rugolo 1987), as well as, some temperate regions of the United States of America (California, Texas and Ohio), and the Hawaiian Islands (Hawaii, Kauai, Molokai, Oahu) (Hitchcock 1950). Recently, it was recorded from San José, Costa Rica (Davidse 1998). In Australia, it is an abundant weed of inundated places (Vickery 1941). Nicora and Rugolo (1987) and Zuloaga et al. (1994) recognize this taxon in the segregate genus *Lachnagrostis*.

In Mexico, *Agrostis avenacea* was collected from the municipalities of Huimilpan and Amealco, in the southern portion of the state of Queretaro (Fig.

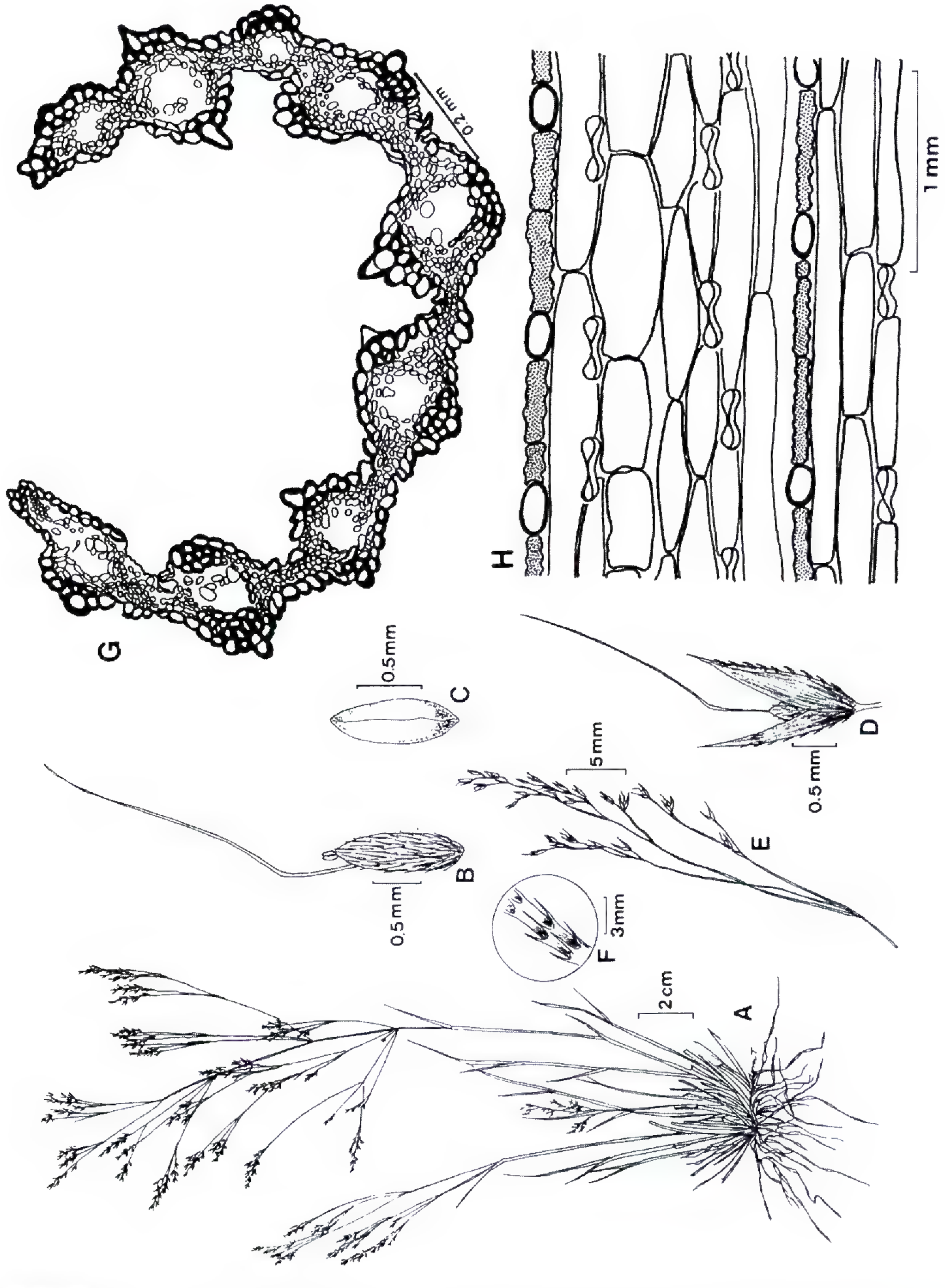


Fig. 1. *Agrostis avenacea* J.F. Gmel. (*M. Martínez 2936*, QMEX). A. Habit. B. Floret. C. Caryopsis. D. Spikelet. E. Inflorescence branches. F. Indument of inflorescence branches. G–H. Leaf blade anatomy. G. Detail of transverse section (*M. Martínez 2936*, QMEX). H. Abaxial epidermis as seen in surface view (*M. Martínez 2953*, QMEX). Stippling indicates the costal region in H.

2A). This species has not been previously reported in any floristic study from Mexico. This taxon was introduced to U.S.A (Hitchcock 1950; Davidse et al. 1998). In California and texas, plants of *A. avenacea* act like tumble weeds and its dried panicles are carried widely by wind and in the process dispersing seeds. It is unknown whether the populations of *A. avenacea* from Mexico is the result of long-range wind dispersion, or by some other manner, such as by vehicles passing through wetlands and picking up spikelets and panicles. It is probable that this taxon is growing in other states of Northern Mexico, as well.

Specimens examined: **MÉXICO: Querétaro:** Mpio. Huimilpan, arroyo La Beata, km 42 carretera Querétaro-Amealco-La Beata, 20° 21' LN y 100° 13' LW, 2350 msnm, 15 May 1996, *Martínez 2936*. Mpio. Huimilpan, "La Calle," km 33 Carretera Querétaro-Amealco, hacia las afueras de Huimilpan, 20° 22.5' LN, 100° 16.5' LW, 2280 msnm, 15 May 1996, *Martínez 2952, 2953, 2955*; Mpio. Amealco, km 31 carretera Amealco-San Juan del Rio, 2 km al E de Amealco, charco permanente a la orilla de la carretera, 20 12.84' LN, 100° 9.16' LW, 2490 msnm, 25 Jul 1996, *Martínez 3331, 3333*; Mpio. Amealco, km 5 carretera Amealco-San Ildelfonso, charco temporal, 20° 10.80' LN, 100° 5.40' LW, 2640 msnm, 5 Nov 1996, *Martínez 3667* (QMEX, duplicates for distribution to IEB and MEXU)

Agrostis avenacea is distinguished by its slender, thin and lax inflorescences. The spikelets of mature inflorescences are easily dispersed by the wind.

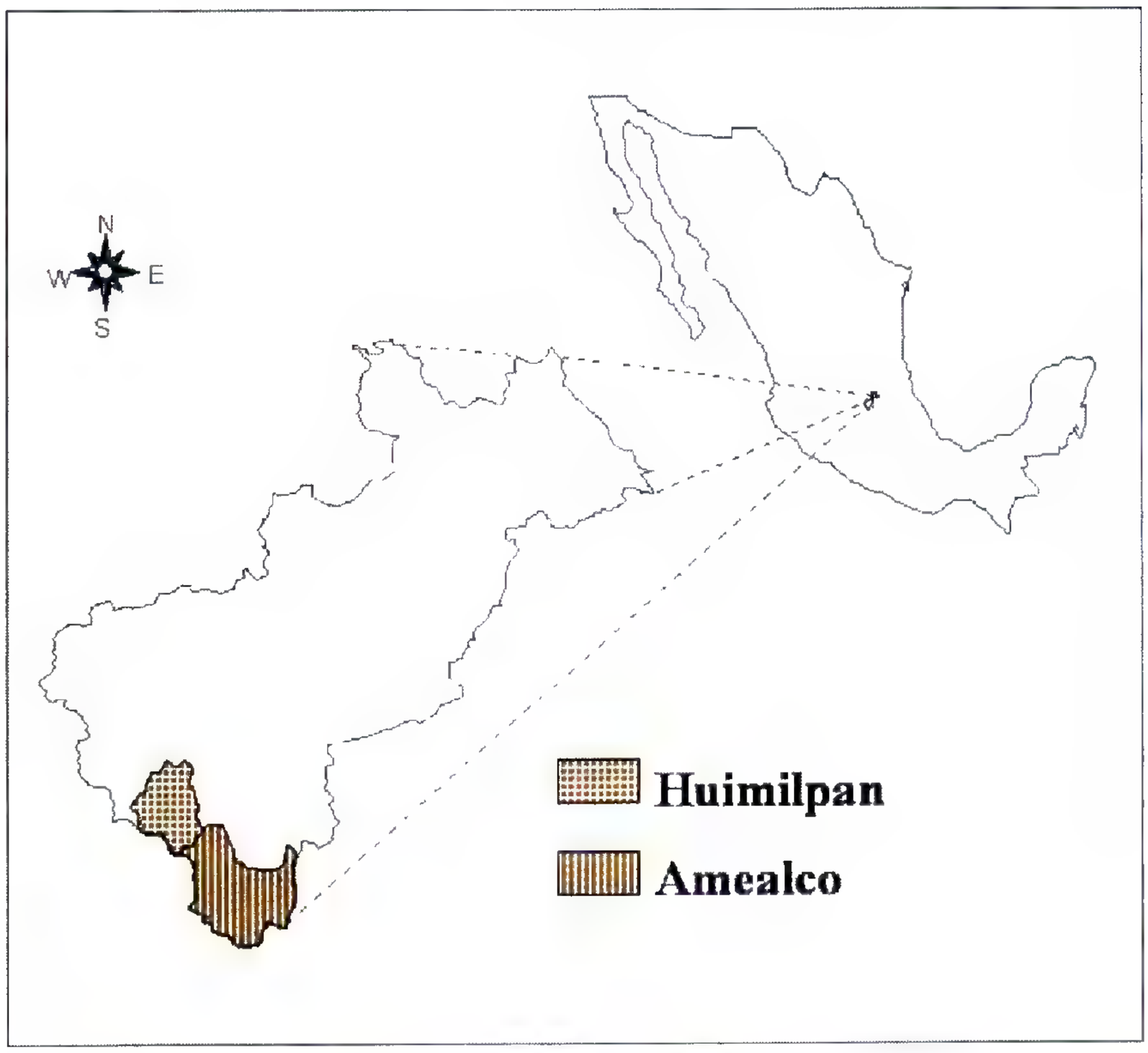
Leaf blade anatomy

The abaxial epidermis and inner structure of the leaf blade were studied. The epidermis and transverse sections were obtained following Gomez-Sánchez and Koch (1998).

Abaxial epidermis.—Differentiation of the costal and intercostal zones inconspicuous. Long cells, fusiform, longer than wide. Stomata abundant, 37–39 µm long, parallel-sided subsidiary cells, guard cells hidden by interstomatal long cells. Papillae absent. Prickles a few in the costal zone. Silica bodies, microhairs and macrohairs absent (Fig. 1H).

Transverse section.—Outline of the blade U-shaped, nodular. Abaxial and adaxial surface with rounded ribs associated with all vascular bundles; abaxial and adaxial furrows broad and deep. Vascular bundles nine; usually first order vascular bundles. Outer vascular bundle sheaths absent. Sclerenchyma costal strands present, the abaxial in 2–4 cells wide and 1–2 cells tall, the adaxial in 1–3 cells wide and 1–2 cells tall or absent. Chlorenchyma nonradiate, its cells of various sizes and shapes, continuous between adjacent vascular bundles. Colorless parenchyma cells absent. Bulliform cells in fan-shaped, adaxial groups no conspicuous, central cell relatively small, or absent (Fig. 1G).

Agrostis avenacea is clearly a member of the Pooideae in its anatomical features. It is a Non-Kranz species, with C_3 photosynthetic metabolism (Hattersley & Watson 1975). It has a typical "pooid" anatomy, characteristic of those species that grow in temperate climates. The leaf blade is nodular with ribs and deep furrows in the abaxial and adaxial surfaces. The limited development of



A



B

FIG. 2. Region of Mexico where *Agrostis avenacea* was colected. 2A. Map showing Municipalities of Amealco and Huimilpan of the State of Querétaro, Mexico. 2B. Temporary pond in the Municipality of Amealco in the Satate of Queretaro.

abaxial and adaxial sclerenchyma explains the presence of the breakable and lax culms and suggests that *Agrostis avenacea* is adapted to wet habitats.

Several taxonomic treatments of *Agrostis* exist (Acosta-Castellanos 1990; Pohl 1980; Pohl & Davidse 1994; Davidse 1998), however these treatments are partial and taxonomic affinities of the species are uncertain. The genus *Agrostis* urgently needs a world revision (Pohl & Davidse 1994; Davidse 1998). In addition to the morphological, anatomical, micromorphological work, the development of molecular studies will be a very important contribution to circumscription of *Agrostis* species.

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Annotations and comments by the Editor

Systematics/Monographs/Floras/Guides

Ancille Glouden and Cicely Tobisch. 1995. **Orchids of Jamaica.** (ISBN 976-640-002-4, pbk.). The University of West Indies Press, 1a Aqueduct Flats, Kingston 7, Jamaica, WI (Orders: University of Oklahoma Press, 4100 28th Avenue, Norman, OK 73069-8218; www.oupress.com, 405-307-9048 fax). $26.00, 222 pp., numerous color photos, 6" × 9".

Key Words: Orchids, Jamaica, flora, field guide, identification, descriptions, 125 species.

Fritz Hochstätter. 2000. ***Yucca* I (Agavaceae). (Dehiscent-Fruited Species) in the Southwest and Midwest of the USA and Canada with Seed Morphology by Dr. Günter Hentzschel. English Translation by Chris Holland.** (ISBN 3-00-005946-6, hbk.). Fritz Hochstatter, P.O. Box 510201,D-68242 Mannheim, Germany; Hamlyn Valley, Box 11, Modena, UT 84753, U.S.A. (Orders: fhnavjo@aol.com; members.aol.com/fhnavajo; www.cactus-mall.com/navajo; www.cactus-mall.com/cdrom/yucca.html; 0621-79-00332 fax). Price not given, 256 pp., 189 figures, with many color photos, line drawings, and maps, 6 3/4" × 9 3/4".

Key Words: Yucca, Agavaceae, flora, systematics, descriptions, illustrations, keys, morphology, anatomy of Yucca seeds, ecology, pollination, USA, Canada, reproductions of original descriptions.

At least two new names are proposed in the book, *Yucca harrimaniae* Trelease ssp. *gilbertiana* (Trelease) Hochstätter stat. nov. (page 36) and *Yucca arkansana* Trelease ssp. *freemanii* (Shinners) Hochstätter, comb. et. stat. nov. (page 61).

Horticulture/Gardening

Barbara Perry Lawton. 2002. **Mints: A Family of Herbs and Ornamentals.** (ISBN 0-88192-524-1, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $27.95, 272 pp., 61 color photos, 5 b/w photos, 46 line drawings, 6" × 9".

Key Words: Lamiaceae, mints, herbs, ornamentals, gardening, cultivation, classification, catalog, 67 genera

AN UPDATE TO THE VASCULAR FLORA OF CALCASIEU PARISH, LOUISIANA

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ABSTRACT

The publication of a vascular flora survey of Calcasieu Parish, Louisiana by Neyland et al. in 2000 is updated and revised. Subsequent field and herbarium research has yielded the discovery of four new species for the parish. Additionally, six species that had been previously reported by other sources to occur the parish but were not discovered during Neyland et al,'s original survey have been collected. Two corrections from the original survey are also noted.

KEY WORDS: Vascular Plant Survey, Calcasieu Parish, Louisiana

RESUMEN

La publication de un inventario de flora vascular de Calcasieu Parish, Louisiana por Neyland et al. en 2000 se pone al día y se revisa. La investigación subsiguiente de campo y herbario ha tenido como consecuencia el descubrimiento de cuatro nuevas especies para parroquia. Adicionalmente, se han colectado seis especies que habían sido citadas previamente por otras fuentes en la parroquia pero no fueron descubiertas durante la inspección original de Neyland et al. Se hacen también dos correcciones al catálogo original.

This paper updates and revises the original vascular flora survey of Calcasieu Parish, Louisiana of Neyland et al. (2000). Specifically, the purpose of this study is to list new collections from the Parish and to correct errors from the original survey.

METHODS

Since the publication of the original survey by Neyland et al. (2000) until present, plant collections from Calcasieu have continued. Voucher specimens were prepared using standard herbarium practices and are housed at the McNeese State University (MCN) Herbarium. Additionally, specimens from other herbaria have been examined. Nomenclature follows Kartesz (1999).

RESULTS

The following entries are new additions to the vascular flora of Calcasieu Parish. These taxa have not been reported previously as occurring in the parish. Specimen references follow the same format as in the original survey (Neyland et al. 2000). Authorities are abbreviated according to Brummitt and Powell (1992). Following the collection data is an abbreviation for the vegetative region

where each species typically occurs: prairie (Pr); longleaf pineland (Pi). Although not a vegetation region, disturbed areas such as pastures, fallow fields, ditches, urban areas and roadsides are collectively abbreviated (D).

AMARYLLIDACEAE
Zephyranthes candida (Lindl.) Herbert (MCN) *Neyland 1944* D

ASTERACEAE
Bidens alba (L.) DC. (MCN) *Neyland 1940* D

LAMIACEAE
Nepeta cataria L. (MCN) *Walker s.n.* D

ORCHIDACEAE
Platanthera integra (Nutt.) Gray ex Beck (AMES) *Cocks s.n.* Pi

The following entries have been previously reported in the parish but were not collected during the original survey of Neyland et al. (2000). Therefore, these collections provide recent evidence for their presence in Calcasieu Parish.

ASTERACEAE
Coreopsis pubescens Ell. var. *debilis* (Sherff) E.B. Smith (MCN) *Neyland 1951* D, Pi
Silphium integrifolium Michx. (MCN) *Neyland 1947* D, Pr

EUPHORBIACEAE
Chamaesyce hirta (L.) Millsp. (MCN) *Neyland 1939* D

JUNCACEAE
Juncus bufonius L. *Haning 8* (MCN) D, Pi, Pr

LAMIACEAE
Scutellaria drummondii Benth. (MCN) *Neyland 1927* D

OXALIDACEAE
Oxalis violacea L. (MCN) *Neyland 1945* D, Pi, Pr

The following entries were misidentified in the original survey. Subsequent annotations have resulted in the noted corrections.

1. The specimen originally reported as *Asclepias variegata* L. *Neyland 1763* **Pi** is *Asclepias obovata* Ell. Therefore, this species is removed from the survey.

2. The specimen reported as *Juncus elliottii* Chapm. *Brooks 609* (MCN) **D, Pi, Pr** is *Juncus acuminatus* Michx. However, the species does occur in the parish as evidenced by the specimen designated as *Juncus elliottii* Chapm. *Giltner 37* (MCN) **D, Pi, Pr.**

DISCUSSION

The most notable addition to the flora of Calcasieu Parish is the discovery of a specimen of *Platanthera integra* in the Oakes Ames Herbarium at Harvard. This specimen was collected by R.S. Cocks in September, 1906; however, additional collection information is absent from the herbarium sheet. *P. integra* is presently rated by The Natural Heritage Program of the Louisiana Department of Wildlife and Fisheries as "S2" which is defined as rare and local throughout

the state or found locally in a restricted region of the state. This apparently is the only known specimen that has ever been collected in Calcasieu Parish. Because suitable habitat for this species largely has been destroyed in the parish (Neyland et al. 1998), it may be extirpated.

As a result of these revisions to the original vascular flora survey of Calcasieu Parish, the number of confirmed specific and subspecific entries for the parish is increased to 1,153. The number of reported but unverified entries for the parish is reduced to 131.

ACKNOWLEDGMENTS

I thank Sara Thames, University of Louisiana at Monroe, Monroe, LA, John Miller, Lake Charles, LA, Bruce A. Sorrie, Longleaf Ecological, Whispering Pines, NC and Lowell E. Urbatsch, Louisiana State University, Baton Rouge, LA for their assistance.

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Books Received/Notices

Annotations and comments by the Editor

Horticulture/Gardening

Loran M. Whitelock. 2002. **The Cycads.** (ISBN 0-88192-522-5, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $59.95, 532 pp., 505 color photos, 13 line drawings, 8 1/2" × 11".

Key Words: Cycads, horticulture, cultivation, propagation, distribution, classification, morphology, reproduction, conservation, 11 genera, ca. 300 species.

This is one encyclopedia of information on cycads. The 505 color plates are exceptionally nice. If you are into cycads then you will want this book.

John Bryan. 2002. **Bulbs, Revised Edition.** (ISBN 0-88192-533-0, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $89.95, 896 pp., 1171 color photos, 10 line drawings, 2 charts, 8 1/2" × 11".

Key Words: Bulbs, landscape, horticulture, gardening, catalog, worldwide.

This is an impressive revised edition. The book is worth the price in just the color plates alone. There are many color plates reproduced from Curtis's Botanical Magazine. Just beautiful!

Jane McGary (editor). 2001. **Bulbs of North America.** (ISBN 0-88192-517-9, pbk.). Timber Press and North America Rock Garden Society (Orders: Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A., www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $34.95, hbk., 308 pp., 101 color photos, 4 line drawings, 2 maps, 6" × 9".

Key Words: Bulbs, landscape, horticulture, gardening, catalog, North America.

Contents include: 1) The Genus *Allium*; 2) Amaryllidaceae of North America; 3) The *Brodiaea* Alliance: *Bloomeria*, *Brodiaea*, *Dichelostemma*, and *Triteleia*; 4) The Genus *Calochortus*; 5) The Genus *Erythronium*; 6) The Genus *Fritillaria*; 7) Irids of the Southeast; 8) The Genus *Lilium*; 9) Bulbs of the Northwest; 10) Bulbs of the Southwest; and 11) Bulbs of Eastern North America. Information is provided on sources of bulbs and seeds.

NEW VASCULAR PLANT RECORDS FOR TEXAS

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Study of previous collections brings to light records for two species (Asteraceae, Caryophyllaceae) previously unreported for the state of Texas.

Anaphalis margaritacea (L.) Benth.

Anaphalis margaritacea occurs over most of the western and northern United States and Canada—it has not been recorded from Texas, Oklahoma, and states of the southeastern USA (Kartesz 1999). In Mexico it is known from localities in northern Baja California (Wiggins 1980). It is reported from eight primarily montane counties in New Mexico (Martin & Hutchins 1981), where it occurs at 7000–10,000 feet elevation, and from several prairie counties in Colorado (Great Plains Flora Association 1976). The record from the Texas panhandle reported here is a southeastward 'outlyer' from the main range but it is a relatively small step eastward from the known localities in New Mexico and Colorado. The Brewster Co. collection is disjunct southward about 350 kilometers from the closest localities in Lincoln Co., New Mexico. Other UNM collections (fide Jane Mygatt, UNM Collection Manager) confirm that Ora Clark was botanizing in Brewster County in the first week of August 1931, adding a degree of confidence that the *Anaphalis* collection did originate from there.

Voucher specimen: **TEXAS. Brewster Co.:** "arroyas, s. Terlingua, Texas," 5 Aug 1931, *Clark 4199* (UNM). **Hale Co.:** Plainview, E of Co-op Cotton Compress on side of railroad, sandy soil, 3350 ft, 11 Sep 1967, *Hall s.n.* (WIS).

Gypsophila elegans M. Bieb.

Gypsophila elegans (var. *elegans*) is native to Russia (Black Sea region), Crimea, Caucasus, eastern Turkey, and Iran (Caspian Sea region) and is adventive in western Europe and North America (Barkoudah 1962), where it is grown as a garden plant. *Gypsophila elegans* var. *latipetala* Barkoudah is known only from "Turkey and Transcaucasia" (fide Barkoudah 1962). Variety *elegans* is known from scattered localities in Canada and the USA (including California, Utah, Colorado, Kansas, Illinois, North Carolina (Kartesz 1999). The central and north-central Texas localities reported here are the southernmost known stations in North America.

A key in the treatment of *Gypsophila* for California (Hartman 1993) separates *G. elegans* from *G. paniculata* L. and *G. scorzonerifolia* Ser. Gleason and

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Cronquist (1991, p. 127) included a brief description and comment regarding *G. elegans*, following the description of *G. muralis* L., noting that it "occasionally escapes from cult. in our range." It is possible that the Texas plants are from direct roadside seeding—the species is distributed as part of 'Texas/Oklahoma,' 'Mountain,' 'Northeast,' Gulf Coast/Caribbean,' and 'Southeast' wildflower seed mixes (see www.prairiefrontier.com/pages/pfmixpg/regional.html). Another website touts the species as "One of the easiest seeds to grow. This plant literally pops out of the ground in any soil, ready to bloom." A search for the Tarrant County plants at the Keller site in 2002 was unsuccessful, however, suggesting that the species is not successfully reproductive in north central Texas.

The common name of *Gypsophila elegans* is Annual Baby's Breath or Showy Baby's Breath. Many photos of the species are available on the internet, including an excellent one of a herbarium specimen (linnaeus.nrm.se/flora/di/caryophylla/gypso/gypsele.html).

Voucher specimen: **TEXAS. Erath Co.:** roadside of Hwy 377, ca. 7 mi S of Stephenville at intersection of Co. Rds. 379 and 380, in ditch on NW side of highway, with 'oats, wheat, bermudagrass, rescuegrass and bluebonnets,' 15 Apr 2001, *Kunselman 23* (TAC). **Tarrant Co.:** along railroad tracks in township of Keller, NE of Fort Worth, Apr 2001, *O'Kennon* (sight record only).

ACKNOWLEDGMENTS

The new records reported here are from among specimens in loans to BRIT from WIS, TAC, and UNM. The Tarrant County collection of *Gypsophila* was independently identified by Richard Rabeler. Review comments of Lindsay Woodruff are greatly appreciated. Jane Mygatt provided helpful information on Ora Clark and his collecting schedule.

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NOTES ON THE FLORA OF TEXAS WITH ADDITIONS AND OTHER SIGNIFICANT RECORDS. II

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ABSTRACT

The following ten taxa are documented new to Texas: *Aster laevis* var. *purpuratus*, *Bidens alba* var. *radiata*, *Tridax procumbens*, *Raphanus raphanistrum*, *Calycanthus floridus* var. *glaucus*, *Lyonia lucida*, *Hyptis mutabilis*, *Lilium longiflorum*, *Lythrum lineare*, and *Myrtus communis*. Significant new collection records are provided for eight: *Hypochaeris glabra*, *Cyperus cephalanthus*, *Rhynchosia tomentosa*, *Quercus arkansana*, *Allium stellatum*, *Cuphea viscosissima*, *Oenothera elata* subsp. *hirsutissima*, and *Leptochloa dubia*. Taxa are listed alphabetically by family, genus, and species with comments and citation of voucher specimens.

RESUMEN

Los siguientes diez taxa se citan nuevos para Texas: *Aster laevis* var. *purpuratus*, *Bidens alba* var. *radiata*, *Tridax procumbens*, *Raphanus raphanistrum*, *Calycanthus floridus* var. *glaucus*, *Lyonia lucida*, *Hyptis mutabilis*, *Lilium longiflorum*, *Lythrum lineare*, y *Myrtus communis*. Se hacen citas significativas de otros ocho nuevas recolecciones: *Hypochaeris glabra*, *Cyperus cephalanthus*, *Rhynchosia tomentosa*, *Quercus arkansana*, *Allium stellatum*, *Cuphea viscosissima*, *Oenothera elata* subsp. *hirsutissima*, y *Leptochloa dubia*. Los taxa se listan alfabéticamente por familia, género y especie con comentarios y cita de los especimenes testigo.

INTRODUCTION

Floristic work in the Houston area and other east Texas counties, coupled with plants sent to the SBSC herbarium for identification, has revealed a number of plants new to Texas and significant new records for others.

Unless otherwise indicated, all collections cited in this paper are in the Spring Branch Science Center Herbarium (SBSC), Houston, Texas. Duplicates of some collections are at the other indicated herbaria. Herbarium acronyms follow Holmgren et al. (1990).

ASTERACEAE

Aster laevis L. var. **purpuratus** (Nees) A.G. Jones.—*Aster laevis* has been represented in Texas by the western variety *geyeri* in the Guadalupe Mts of Culberson Co. (Nesom 1993). Here we report variety *purpuratus*, the narrow leaved southeastern entity, from two east Texas counties. Thomas and Allen (1996)

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mapped it in six, mostly north central, Louisiana parishes. Kartesz (1999) mapped it, as *Symphyotrichum laeve* (L.) A. & D. Love var *purpuratum* (Nees) Nesom, in Georgia, Alabama, Mississippi, Louisiana, Arkansas, and Texas. At the Polk County site, *A. laevis* var. *purpuratus* is distinguished from the similar and more numerous plants of *A. oolentangiensis* Riddel by smooth leaves in contrast to the harshly scabrous leaves of *A. oolentangiensis*.

Voucher specimens: **Polk Co.:** growing in a native calcareous prairie surrounded by pine-oak woods at the intersection of Lone Wolf Road and Windham Road, N of Hwy 1988 between Goodrich and Providence, S of Livingston, 30° 37'33"N and 94° 55'33"W, 28 Oct 2000, *Brown 24913*; same site, 23 Sep 1999, *Brown 23563*. **Tyler Co.:** collected in a calcareous prairie barren on U.S. Hwy 190, ca. 4.5 mi W of intersection with FM 92, 12 Jun 2000, *J. Liggio s.n.*

Bidens alba (L.) A. DC. var. **radiata** (Sch. Bip.) Ballard ex T.E. Melchert.—Ballard (1986) divided the *B. pilosa* complex into three mostly tropical American species, namely *B. alba*, *B odorata* Cav., and *B. pilosa* L. He mapped United States records of *B. alba* var. *radiata* in Florida and *B. pilosa* in California. Wunderlin (1998) reported *B. alba* var. *radiata* as common and distributed nearly throughout Florida. Gandhi and Thomas (1989) reported *B. pilosa*. in Louisiana but indicated that Ballard's description of *Bidens alba* var. *radiata* was in concurrence with their description of *B. pilosa*. Thomas and Allen (1996) maintained *B. pilosa* in Louisiana and mapped it in thirteen parishes. We report *B. alba* var. *radiata* (sensu Ballard) from four Texas counties. There is a photograph of the taxon in Tveten and Tveten (1993).

Voucher specimens: **Cameron Co.:** common in a vacant lot in Brownsville, 1 Apr 1983, *Brown 5954*. **Chambers Co.:** along I-10 at the bridge over the Trinity River near the village of Wallisville, 29° 50' 12"N and 94° 39'08"W, 8 Oct 2000, *Brown 24801*. **Harris Co.:** weed along Old Katy Rd at Bunker Hill in Houston, 19 Oct 1990, *Tveten b-390*; weedy plants at the intersection of Dell Dale and Brentwood Streets in Channelview, 21 May 1992, *Brown 16084*. **Montgomery Co.:** edge of small woodland next to parking lot near Woodlands Parkway, 1/4 mi W of I 45, 8 Dec 2001, *E. Keith 31*.

Hypochaeris glabra L.—Diggs et al. (1997) reported this European weed new to Texas from Williamson County. Since then additional collections have been made in other regions of the state.

Voucher specimens: **Harris Co.:** weedy plants in a subdivision adjacent to a small native prairie at intersection of Greenhouse Rd and FM 529, 29° 52'42"N and 95° 42'14"W, 12 Mar 1999, *Brown 22866*; plants on sandy soil in pasture on south side of the Harris County Katy Park, N of Katy, 29° 48'34"N and 95° 48'20"W, 14 Apr 2001, *Brown 25083*. **Leon Co.:** growing on sandy soil in the Boykin Cemetery off of Hwy 831 between Oakwood and Flo, 18 Apr 2001, *Brown 25090*. **Waller Co.:** on sandy soil at the intersection of Holik Rd and Hwy 1887, west of the Monaville cemetery and between Hempstead and Pattison, 29° 56'58"N and 96° 04'51"W, 8 May 2002, *Brown 26702*.

Tridax procumbens L.—Kartesz (1999)reported this exotic and federal noxious weed in Florida and Hawaii. Wunderlin (1998) reported it frequent in the central and southern peninsula of Florida. John Tveten recently sent a collection of it from the Valley Nature Center in Hidalgo County for identification. Regarding the history of the plant in Texas, the following communication was

received from Ken King and Martin Hagne of the Valley Nature Center; "Seed was collected in the Brownsville area by a native grower several years ago. That grower is no longer in the area and we do not know the exact Brownsville location. The plants at the Valley Nature Center were planted here from those seedlings. This comp is growing in empty lots throughout Weslaco and has been in the area for at least fifteen years. We have seen several local establishments around town. There are at least two south Texas counties that have communities of this plant; Hidalgo and Cameron." Alfred Richardson (1995) did not include this taxon for the Rio Grande Delta area.

Voucher specimen: **Hidalgo Co.:** spreading along trails in open spots in mesquite bush in the Weslaco Valley Nature Center, 20 Nov 2001, *Tveten s.n.*

BRASSICACEAE

Raphanus raphanistrum L.—Rollins (1993) distinguished the genus *Raphanus* by a segmented fruit with the lower segment inconspicuous and seedless. The petal colors vary from white, yellow, lilac, to violet. Rollins (loc cit.) reported two introduced weedy species in North America, *R. raphanistrum* and *R. sativa*. He indicated that in *R. raphanistrum* the fruits are linear, longitudinally grooved, and strongly constricted between the seeds. The petals are yellow and fade to whitish or white. In *R. sativus* the fruit body is widest at the base, smooth or very slightly grooved, and is not or only poorly constricted between the seeds. The petals are usually purple. The petal veins are prominent in yellow flowered *R. raphanistrum*, which can distinguish it from yellow petaled plants of *Brassica* and *Sinapsis*, if one does not notice the small lower fruit segment. Kartesz (1999) mapped it in Texas *fide* Gould (1975a) but no voucher was provided. It is not listed in Correll and Johnston (1970) nor any of the recent checklists. We report voucher material with the traits of *R. raphanistrum* from three Texas counties. Thomas & Allen (1996) mapped *R. raphanistrum* in numerous northern and southern Louisiana parishes. Two of these parishes are adjacent to Texas. In contrast, *R. sativus* is known from only seven parishes. Wunderlin (1998) found *R. raphanistrum* more common in Florida than *R. sativa*. A reexamination of Texas material may reveal the same situation in Texas.

Voucher specimens: **Fort Bend Co.:** yellow flowered weedy plant along a gravel road above a drainage ditch at extreme SW edge of Barker Reservoir, ca. 1/2 mi E of Mason Rd and ca. 1/2 mi N of FM 1093, 10 Mar 1995, *Brown 18435*. **Harris Co.:** Brays Bayou at Buffalo Speedway in Houston, 18 Mar 2000, *D. Johnson s.n.* **San Jacinto Co.:** collected along roadside of Hwy 945 near the Evergreen Cemetery in the village of Evergreen, 9 Mar 2001, *E. Keith s.n.*

CALYCANTHACEAE

Calycanthus floridus L. var. **glaucus** (Willd.) Torr. & A. Gray.—At least fifteen plants of this shrub are present in woods adjacent to the David and Patricia Lewis residence in Newton County. In a personal communication, the Lewises indicated that these plants were here when they established a residence on the

site. Thomas and Allen (1996) were unsure of the native status of a collection from West Feliciana Parish, Louisiana. Likewise we are uncertain of their native status here; however, they are well established and naturalized shrubs and should be considered a member of the Texas flora.

Voucher specimens: **Newton Co.:** plants on a mesic slope woodland above Screw Pin Branch adjacent to CR 3062, W of Hwy 87 N of Bleakwood, 22 Jul 2000, *Brown & Elsik 24437* (SBSC, BRIT); same site, 13 Apr 1999, *Lewis, Lewis & Elsik 6169* (SBSC, TEX).

CYPERACEAE

Cyperus cephalanthus Torr. & Hook.—Carter and McInnis (1993) reported the type locality of this sedge from somewhere near Galveston Bay. The type collection was made in 1835 and the species has not been recollected in Texas since. We here report a recent collection from Harris County. Richard Carter (VSC) has verified the identification.

Voucher specimen: **Harris Co.:** tall plants with thick stem in a moist prairie depression a few hundred feet SE of the Texas Chiropractic College, on the S side of Spencer Blvd, a few hundred feet E of Beltway 8 in Pasadena, 29°39'39"N and 95°08'50"W, 29 May 1999, *Brown 23076* (BRCH, SBSC, TEX).

This site is owned by the Harris County Flood Control District and is soon to be formed into a detention basin for downstream flood control along Armand Bayou. However, Ralph Taylor of the Flood Control Environmental Services has removed all plants from the site and replanted them in their nursery near Lake Houston. Plants have been given to the Mercer Arboretum and Botanic Gardens and to the Armand Bayou Nature Center for establishment on their lands.

ERICACEAE

Lyonia lucida (Lam.) K. Koch.—Specimens of these shrubs, with flowers in March and fruits in summer, have been recently collected in Newton County. The shrubs were on the property of David and Patricia Lewis when they set up a residence north of Bleakwood. There was no evidence of a prior human occupation of the site. David has discovered six populations with well over a hundred total plants (per. comm.) along Screw Pin Branch. Fetterbush is native and common in the adjacent Sabine Parish of Louisiana (personal observation by the second author, Thomas and Allen 1996). It is our opinion that this is also a native population.

Voucher specimens: **Newton Co.:** shrubs along Screw Pin Branch, ca. 300 m W of Hwy 87, 1 mi N of the intersection with Hwy 363 in community of Bleakwood, 30°42'29"N and 93°49'34"W, 24 Mar 1999, *Lewis & Elsik 6168a* (SBSC, nine duplicates to be distributed to other herbaria); same site, 22 Jul 2000, *Brown & Elsik 24436*. (SBSC, BRIT).

FABACEAE

Rhynchosia tomentosa (L.) Hook. & Arn.—Turner (1959), Correll and Johnston (1970), Johnston (1990), Hatch et al. (1990), Jones et al. (1997), and Isely (1998) all reported this legume for Texas. Turner (1959) reported a collection by Charles

Wright that lacks locality data. Isely (1998) did not map it in the state. It is also not mapped in the state by Turner et al. (in press). We here report an authentic Texas collection from what is now the Little Rocky Preserve of The Nature Conservancy of Texas.

Voucher specimen: **Jasper Co.:** Little Rocky Nature Conservation area, 13 mi N of Jasper on Hwy 96 to Browndel, then ca. 3 mi E of Browndel on Hwy 1007, 15 Aug 1982, *Peterson 631*.

FAGACEAE

Quercus arkansana Sarg.—Hunt et al. (1995) first reported this oak as new to Texas. They found two small populations in Cass County and an historical record for Jasper County. We here report recent collections from Jasper and Hardin counties. Jensen (1997) mapped it in the extreme northeast and southeast portions of the state.

Voucher specimens: **Jasper Co.:** deep sandy hillside about 2 mi N of the end of FM 2800, NW of Jasper in the headwaters of Hog Creek, 3 Jul 2001, *E. Keith 11b*.

LAMIACEAE

Hyptis mutabilis (Rich.) Briq.—Kartesz (1999) reported this exotic weed in seven southeastern states from Virginia to Louisiana. Thomas and Allen (1998) mapped it in three parishes east of the Mississippi. River. We here report a collection for Texas.

Voucher specimen: **Liberty Co.:** plants growing in a fenced field on S side of the Davis Hill Salt Dome adjacent to the Davis Hill Estates subdivision, east of Cleveland and off of Hwy 105, 30° 18'32"N and 94° 51'01"W, 5 Jul 1999, *Brown 23169*.

LILIACEAE

Allium stellatum Ker.—Turner et al. (in press) mapped this onion in five, mostly north central Texas counties. We here report collections far south of those mapped.

Voucher specimens: **Polk Co.:** in a native prairie surrounded by pine-oak forest along Lone Wolf Rd N of Hwy 1988 between Goodrich and Hwy 146 S of Livingston, 17 Nov 1996, *Brown 19809*. **Brazos Co.:** population of red flowered plants on a gravel slope above Lick Creek, NE of the intersection of Hwy 6 and Greens Prairie Rd, probably within the city limits of College Station, 2 Nov 2001, *Brown 26401* (SBSC, TAMU).

Lilium longiflorum Thunb.—In the summer of 2000, we found this tall white flowered plant to be common and conspicuous along roadsides near Newton. It is also found as an escape from cultivation in Alabama, Florida, and Utah (Kartesz 1999). We identified it to this species with the key in Wunderlin (1998). Thomas and Allen (1993) reported *L. formosum* in Louisiana, but our plants have the totally white flowers of *L. longiflorum*, in contrast to the red-purple outer perianth of *L. formosum*.

Voucher specimens: **Newton Co.:** growing along the gravel CR 3062 between Screw Pin Branch and

Thickety Creek, west of Hwy 87, N of Bleakwood, 22 July 2000, *Brown & Elsik 24438*. **Tyler Co.:** 1.1 mi N of jct Hwy 190/FM 256 W of Woodville, 3 Aug 1991, *Schultz 061*.

LYTHRACEAE

Cuphea viscosissima Jacq.—Correll and Johnston (1970) reported Blue Waxweed in Texas but without a specific locality. Graham (1975) eliminated it from Texas, as did Johnston (1990), Hatch et al. (1990), Jones et al. (1997), Kartesz (1999), and Turner et al. (in press). We here report a voucher to confirm its presence in Texas.

Voucher specimen: **San Augustine Co.:** 8 mi W of San Augustine on Hwy 21, then 1 mi S, Weches formation, 16 Jul 1976, *George & Nixon 43* (SBSC, ASTC).

Lythrum lineare L.—Correll and Johnston (1970), Graham (1975), Johnston (1990), Hatch et al. (1990), Jones et al. (1997), and Turner et al. (in press) did not report this species in Texas. However, Kartesz (1999) listed Texas within its distribution. We provide two vouchers to support its presence in the state. The identification was verified by S. Graham (KE).

Voucher specimens: **Chambers Co.:** Anahuac National Wildlife Refuge, brackish marsh in the Jackson Ditch Unit, 29°35'24"N and 94°25'09"W, 3 Oct 2000, Brown *24774*; Anahuac National Wildlife Refuge, brackish marsh in the East Unit, 29°39'N and 94°28'W, 20 Jul 2000, *Brown 24399* (SBSC, KE)

MYRTACEAE

Myrtus communis L.—Kartesz (1999) did not report this cultivated ornamental plant as occurring wild in the United States. The first author found many well developed shrubs scattered across a salt dome in coastal Texas. These plants had mature fruits and were rather large, suggesting they have been here for some time. The salt dome is isolated and surrounded by a coastal prairie and is for the most part undeveloped except for some old machinery and buildings associated with prior oil extraction.

Voucher specimen: **Brazoria Co.:** shrubs with fruits along gravel road to the center of Hoskins Mound, Galveston-Brazoria Key Map 861 D and H, near 29°08'26"N and 95°13'26"W, 6 Aug 2000, *Brown 24588* (SBSC, TEX, ASU).

ONAGRACEAE

Oenothera elata Kunth subsp. **hirsutissima** (A. Gray ex S. Wats.) W. Dietr.—Dietrich et al.(1997) mapped this taxon largely in Trans-Pecos Texas with one collection from the Panhandle. They also mapped three populations in east Texas in Anderson, Brazos, and Leon counties. Plants matching the key traits and description of this taxon have been collected in Harris and Liberty counties. They are more common on sandy soil in Liberty County. These are tall plants with large yellow flowers whose stigmas are elevated above the stamens.

Voucher specimens: **Harris Co.:** tall herb along Hwy 59 at the San Jacinto River bridge, 28 Jul 1991, *Gregg s.n.* **Liberty Co.:** plants growing on sands along the Trinity River at the Hwy 105 bridge west of Moss Hill, 30°16'39"N and 94°47'57"W, 1 Oct 2000, *Brown 24758*; along the Ace Hwy S of the village of Ace, across from the southern border of the Menard Creek Unit of the Big Thicket Biological Pre-

serve, 30°28'59"N and 94°50'19"W, 25 Aug 2000, *Brown 24680a*; tall plants with rather large flowers on deep sands along the Trinity River, Trinity River Nat Wildlife Refuge at Sevenmile Bend on the Davis Hill 7.5'quad, 30 Aug 1996, *Brown 19528*; large flowered primrose on dry sandy soil along CR 2252 near the Davis Hill Baptist Church E of Cleveland and N of Hwy 105, 15 Sep 1996, *Brown 19693*; a single tall plant at edge of Hwy 146, ca 3 mi N of Moss Hill, 21 Aug 1994, *Brown 18124*; tall weedy plants with large yellow flowers, along dirt road in the Dayton Lake Estates E of Hwy 1008, adjacent to the Trinity River, N of Dayton, 9 Sep 1994, *Brown 18180*.

POACEAE

Leptochloa dubia (H.B.K.) Nees.—Gould (1975b) reported this grass from all regions of the state except for the east Texas pineywoods and the post oak savannah area. We here report collections from two east Texas counties.

Voucher specimens: **Harris Co.:** plants on dark clay soil along a newly constructed road into a prairie at the intersection of Underwood St. and Fairmont Parkway in Deer Park, 29 Sep 1984, *Brown 8100*. **Hardin Co.:** fairly frequent tall grasses on verge of hwy between village of Honey Island and Hwy 69/287, N of Kountze, 6 Sep 1996, *Brown 19565*.

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We wish to thank Tom Wendt (TEX) and Leslie Landrum (ASU) for the identification of *Myrtus communis*, Richard Carter (VSC) for the verification of *Cyperus cephalanthus*, and S. Graham (KE) for the verification of *Lythrum lineare*. Michael MacRoberts provided a literature source and Guy Nesom (BRIT) helped with some nomenclatural questions. Justin Williams (SHST) and Monique Reed (TAMU) reviewed the paper and provided many helpful suggestions. The first author is thankful to the Houston Community College for a sabbatical leave during the spring semester of 2002 that allowed him to complete this project. Publication funds were provided by Rice University.

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Negrete et al. wish to correct their paper, *A checklist for the vascular plants of Padre Island National Seashore* published in the December 1999 issue of SIDA (volume 18, number 4, pp. 1227-1245) by deleting *Sesuvium trianthemoides* from the checklist, which will change the total number of species to 455.

THE RUPERT BARNEBY AWARD

The New York Botanical Garden is pleased to announce that Aaron Liston, currently at the Department of Botany & Plant Pathology, Oregon State University, is the recipient of the **Rupert Barneby Award** for the year 2002. Dr. Liston will be studying the phylogenetic systematics of *Astragalus* and *Trifolium*.

The New York Botanical Garden now invites applications for the **Rupert Barneby Award** for the year 2003. The award of US $1,000.00 is to assist researchers to visit The New York Botanical Garden to study the rich collection of Leguminosae. Anyone interested in applying for the award should submit their curriculum vitae, a detailed letter describing the project for which the award is sought, and the names of 2-3 referees. Travel to the NYBG should be planned for sometime in the year 2003. The application should be addressed to Dr. James L. Luteyn, Institute of Systematic Botany, The New York Botanical Garden, 200th Street and Kazimiroff Blvd., Bronx, NY 10458-5126 USA, and received no later than December 1, 2002. Announcement of the recipient will be made by December 15.

Anyone interested in making a contribution to **THE RUPERT BARNEBY FUND IN LEGUME SYSTEMATICS**, which supports this award, may send their check, payable to The New York Botanical Garden, to Dr. Luteyn.

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BOOK REVIEWS

MARTCO LAMBERTINI (Translated by John Venerella). 2000. **A Naturalist's Guide to the Tropics.** (ISBN 0-226-46828-3, pbk.). The University of Chicago Press, 5801 S Ellis Ave., Chicago, IL 60637-1496, U.S.A. (Orders: 773-702-0279, 773-702-7956 fax, da@press.uchicago.edu, www.press.uchicago.edu). $25.00, 338 pp, 57 color photos, 11 color plates, numerous b/w halftones, 5 1/2" × 7 1/2".

Though unknown to most American readers, the author apparently is professionally trained and works as a conservationist with BirdLife International (UK) and as a freelance scientific journalist. His focus is to educate the public about the importance of conserving the tropics. As he says in the preface, "This is a work that is intended to establish among prospective world travelers a knowledge of the natural life and ecology of the Tropics, to make them seem less distant and unreachable, less unknown and mysterious." In this, I would say he has achieved his goal.

On the other hand, the publisher's flier highlights this book as "the first field guide in English to cover *all* the world's tropics in one volume" and the author states, "a guide to skim before the trip as well as to take along." I would say, "a reference to absorb thoroughly before the trip only." If you are looking for an all-in-one field guide (i.e., birds, mammals, reptiles, sea shells, trees, and flowers), you will be sorely disappointed. If, instead, you want to understand the factors shaping the tropical landscapes that you will be seeing or you want to understand why the tropics are so important, then this is book is worth your money and time.

The first three chapters cover the major physical factors—geologic history, climate and soils—while the next two cover general features of tropical plants and animals. There are five chapters detailing the structure and species of the major ecosystem types in the tropics, i.e., mangroves, forests, coral reefs, savannas, and deserts. The book concludes with an overview of tropical conservation and a series of precautions that travelers should observe to avoid elephant attacks and yellow fever, among others. The layout is very readable and includes many sidebars to extract more difficult or specific information from the general flow of the text. The color photographs are beautiful, and the drawings generally augment the writing.

The introductory chapters are well written and provide a good foundation for understanding tropical environments. The soils chapter should have been longer to relate the greater diversity of tropical soils and the factors giving rise to them. Also, I was surprised that the term, mycorrhizae, was not introduced, although the author did discuss "elevated recycling of nutrients". These chapters cover essential topics, such as, seasonality reflected in the structure and behavior of organisms, primary production, comparisons of similar conditions on different continents, species interactions, and human use. Standard evolutionary explanations are given for the phenomena of symbiosis, defense, population regulation, biodiversity, niches, dispersal, and convergence. The colored plates of birds given in this section are disappointing: 7 species each from Africa and Australasia, 8 from the Americas. The sidebar on palms was illustrated by drawings of only seven species. Having studied this group, I found at least three errors. 1) The drawing of *Phytelephas macrocarpa*, was incorrect. The species pictured represented an entirely different subfamily, probably a poorly drawn *Sabal*. 2) *Licuala grandis* is Asian not South American. 3) Coconut is pantropical, not just Indo-Pacific, although it may have originated there.

The ecosystem chapters are very informative, especially the one on mangroves, in terms of features common to that ecosystem type on all continents. For example, the one on forests distinguishes primary and secondary forests and describes canopy structure, forest characteristics (e.g., root buttresses, lianas, and epiphytes), light gaps and pioneer species, life histories of forest plants, fig-wasp symbiosis, growth of stranglers, ecology of forest animals (sidebars on cicadas, butterflies, ants, poi-

son dart frogs, treehoppers), adaptations of arboreal animals, and pollination and dispersal in the forest.

The last two chapters—conservation and traveling precautions—make this book especially useful and timely.

My recommendation is: Buy this book and read it in depth, book a tropical ecotour, then buy some good field guides for that specific region actually to take with you. And, as the author says, "Buon viaggio!"—*Roger W. Sanders, Associate Collections Manager, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A.*

DAVID BIEK. 2000. **Flora of Mount Rainier National Park.** (ISBN 0-87071-470-8, pbk.) Oregon State University Press. 101 Waldo Hall, Corvallis, OR 97331-6407. (Orders: http://osu.orst.edu/dept/press/osupress.htm, 800-426-3797, 541-737-3166, 541-737-3170 fax). $29.95, 520 pp, 64 color photos, line drawings, 6" × 9".

This publication marks the first comprehensive treatment of the flora of Mount Rainier subsequent to George Neville Jones' work published in 1938. Mount Rainier was designated a National Park in1899 and since then much information has been gathered on the biota of the area. The *Flora of Mount Rainier National Park* by David Biek seeks to update Jones' earlier flora and covers the entire area within the boundaries of the park. According to the author, the goal of this book is "to provide a complete list of the native and introduced plants found in the Park, with keys and descriptions sufficient to distinguish each species from the others."

The volume begins with an introduction on how to use the book and clarifies its scope and intent. The author provides information on how to use the keys to identify plants and forewarns his readers of the inconstant nature of scientific names of plants. Next, facts on the Park, including location, topography and climate are given. The author follows with a discussion of plant communities and associations, citing 19 different types present in the Park and the groups of plants that can be found growing in each zone or community. A brief discussion of plant geography, distribution, weeds and rare plants allow the reader to become familiar with the flora of the Park. Last, a historical overview of explorations and studies, including ecological research on Mount Rainier, gives evidence of the long significance this area has had in our national heritage.

Of course, a majority of the book is dedicated to plants included in the flora and the treatment begins with a key to the major groups of vascular plants. After this key, the major groups are presented, fern and fern allies first, followed by gymnosperms, then dicots and finally monocots. Within each group, the families are listed alphabetically, followed by genera and species. There is a key to accompany each family and genus description so the reader can ascertain the taxon at hand. Species descriptions include scientific name and common name, a brief description of diagnostic characters, elevation, habit and habitat, as well as locations where it has been collected in the Park. Illustrations, reprinted from Hitchcock's *Vascular Plants of the Pacific Northwest*, are adjacent to most species descriptions. Color photos of selected species are found in the middle of the book. An appendix includes 79 plants added to the flora, which were observed by the author in the field or from herbarium specimens between 1996 and 1999. A brief glossary clarifies some essential terms and the bibliography cites critical publications. The author provides a single index with accepted names, synonyms, names misapplied and common names used in the book

Although it is very convenient to have illustrations directly adjacent to the species descriptions, the limited margin results in a small space for inadequate illustration printing. The effect for

some of the illustrations is a print too small to be useful. For example, the illustration for *Pseudotsuga menziesii* includes a cross section of both leaf and stem. Both of these figures are too small to be useful to a reader. Likewise, an illustration of a branch of *Tsuga heterophylla* is so small it is hard to identify the ovulate cones. Perhaps it would have been more useful had the author provided the illustrations in a separate section following the species descriptions that cross-referenced them. The color photos in the middle of the book would be more valuable if scale bars or another unit of measure were included. As the plates are presented, the reader has no frame of reference for how large or small each plant is in the photo. Moreover, it would have been useful to identify each photo with some sort of letter or number so as to be easily cross-referenced with the caption. The discussion on forest communities of Mount Rainier proves a bit confusing. Following the forest classification of another author, Biek states that there are four different forest zones within the Park. These zones are further divided into 19 associations, seven of which have two or more phases. An attempt is made to identify plants commonly growing in each zone, but clearly the distribution and limits of these forests are dependent on innumerable factors, including annual precipitation, disturbance, elevation and temperature. From reading this discussion, it seems likely that many of the communities listed herein are intertwined and thus difficult to classify.

The book has some handy features that are rather noteworthy. Most keys are written with a minimal amount of technical terminology, making them accessible to those with limited botanical knowledge. The author has provided a map of the Park on the inside cover for quick reference to its readers. In addition, a metric ruler provided on the back cover proves convenient when keying out a specimen in the field.

Without doubt, this book is an important update to the knowledge of the flora of Mount Rainier. Those who enjoy the flora of this area would certainly benefit by purchasing a copy of this book, which should prove a worthy and practical field tool. This is a must-have for amateur and professional botanists who enjoy the Northwest United States.—*Amy Trauth Nare, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A. amy trauth@yahoo.com*

DONALD H. MANSFIELD. 2000. **Flora of Steens Mountain.** (ISBN 0-87071-471-6, pbk.) Oregon State University Press. 101 Waldo Hall, Corvallis, OR 97331-6407. (Orders: http://osu.orst.edu/dept/press/osupress.htm, 800-426-3797, 541-737-3166, 541-737-3170 fax). $29.95, 424 pp, 64 color photos, line drawings, 6" × 9".

According to the Mansfield, the flora of Steens Mountain, Oregon includes "all of Steens Mountain from Long Hollow near Fields to Riddle Mountain east of Diamond, the entire Alvord Basin, the Pueblo Valley, Catlow Rim and the eastern edge of Catlow Valley, Diamond Craters, and the Malheur Marsh." The author also claims this book would be useful for the surrounding Pueblo Mountains and Harney Basin as well as most of southeastern Oregon, southwestern Idaho, and northern Nevada. Indeed, this publication would provide a useful tool for those interested in the flora of the northwestern United States.

The book's introduction begins with a discussion on how it is organized, specifics on the geographic region covered and more detailed information on Steens Mountain and surrounding areas. A short geologic and biogeographic history of Steens follows, then a floristic overview of Steens Mountain and an explanation of vegetation zones and plant communities. Mansfield provides an interesting discussion on what makes a plant rare, followed by a listing of some rare plants of Steens. Next, a brief history of botanical exploration on Steens is given, as well as information on how to use the

keys in this book and how to make a proper plant collection. Last, a brief discussion of scientific and common names and the benefits and detriments of each is provided.

A large portion of the book is dedicated to plants included in the flora, begins with a key to the families, and is followed by an alphabetical, rather than phylogenetic, listing of families. Within each family contains the genera and species found on Steens. The author has provided recognition features, or identifying characters, for each family; those that would be especially useful for an amateur botanist. As well, he includes interesting tidbits of information on each family, such as the economic importance of Poaceae and the fruit-bearing cultivars of Rosaceae. The etymology of each genus helps the reader understand the origins of sometimes difficult scientific names. Within each genus is a key to species, followed by a brief description of each species, common names, habitat and distribution. After the listing of families, a useful glossary follows, which clearly defines potentially confusing terms and cross references line drawings that follow. These illustrations would be particularly useful in teaching the amateur botanist about the seemingly infinite morphological diversity of angiosperms. The author provides three separate indices for families, genera and common names, respectively.

Although this book is in general well written, I have but a few minor criticisms. The author claims that the keys are written with the motivated novice in mind. As with most useful keys, however, much technical verbiage is included and could pose difficulty for someone with a limited knowledge of botanical terminology or diagnostic morphologic characters of flowering plant families. On the positive side, the glossary included at the end of the book is useful for clarifying any 'confusing' terms. In his discussion of rare plants on Steens Mountain, Mansfield explains why plants are endemic, citing two types, paleoendemics and neoendemics. While he states that the endemic plants of Steens are neoendemics, he provides no evidence for this observation other than a passing comment on alpine habitat (p.14). The discussion also includes a brief discussion of rare plants in the context of geologic history. Few, if any, amateur botanists or outdoor enthusiasts would have any understanding of geologic time periods. This discussion may be confusing or have little value for the novice reader. By comparison, the information that follows on how to use a key and make proper plant collections are integral in training the reader in proper botanical exploration and collection. In the center of the book, the author provides some high quality color plates, but these photos would be more valuable had scale bars or another unit of measure was provided. As they are given, the reader has no frame of reference for how large or small each plant is in the photo. In addition, it would have been useful to identify each photo with some sort of letter or number so as to be easily cross-referenced with the caption. To the author's credit, his introduction includes comments regarding the completeness of the *Flora of Steens Mountain*, noting that "the flora of Steens Mountain is certainly not finished...there will undoubtedly be more collections of plants not now included in the flora." Too often, this point is forgotten when a work such as this is published. Knowledge of biodiversity is certainly not complete and the dynamic nature of systematics ensures that we will continue learning about the flora of our continent.

This book provides a valuable addition to the knowledge of the flora of the Northwest. Certainly, outdoor enthusiasts and naturalists of southwest Oregon and surrounding areas would benefit by purchasing a copy of *Flora of Steens Mountain*. It is the perfect size for a field guide and would prove a valuable tool for those who tool around Oregon.—*Amy Trauth Nare, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A., amy trauth@yahoo.com*

ROBERT H. MOHLENBROCK. 2001. **The Illustrated Flora of Illinois. Grasses: Panicum to Danthonia, Second Edition. Illustrations by Miriam W. Meyer and Paul W. Nelson.** (ISBN 0-8093-2360-5, hbk.) Southern Illinois University Press. P.O. Box 3697, Carbondale, IL 62902-3697. (Orders: 618-459-6633, 618-453-1221 fax). $50.00, 455 pp, 306 line drawings, 5 1/2" × 8 1/2".

ROBERT H. MOHLENBROCK. 2001. **The Illustrated Flora of Illinois. Flowering Plants: Pokeweeds, Four-o'clocks, Carpetweeds, Cacti, Purslanes, Goosefoots, Pigweeds, and Pinks. Illustrations by Paul W. Nelson.** (ISBN 0-8093-2380-X, hbk.) Southern Illinois University Press. P.O. Box 3697, Carbondale, IL 62902-3697. (Orders: 618-459-6633, 618-453-1221 fax). $59.95, 277 pp, 139 line drawings, 6" × 9".

ROBERT H. MOHLENBROCK. 2001. **The Illustrated Flora of Illinois. Sedges: Cyperus to Scleria, Second Edition. Illustrations by Fredda Burton and Mark W. Mohlenbrock.** (ISBN 0-8093-2358-3, hbk.) Southern Illinois University Press. P.O. Box 3697, Carbondale, IL 62902-3697. (Orders: 618-459-6633, 618-453-1221 fax). $39.95, 223 pp, 128 line drawings, 5 1/2" × 8 1/2".

These three books provide one new edition and two revised editions to the flora of Illinois. Each book begins with a county map of Illinois and a brief introduction about the groups covered within. Taxonomic descriptions, illustrations and distribution maps for each species follow the introduction. The books also contain a list of species excluded, a brief and basic glossary, literature cited, and a single index for both common and scientific names. The editions of *Grasses* and *Sedges* have appendices, which follow the species descriptions. These appendices seek to update any changes in nomenclature and classification since the first edition. In the appendices, only taxa new to the flora are illustrated and distribution maps are not provided.

The *Grasses* volume covers half of the 99 genera found in the Illinois flora, including those in the following subfamilies: Panicoideae, Eragrostoideae, Bambusoideae, Oryzoideae, and Arundinoideae. The introduction to the *Grasses* volume includes a short, but nonetheless informative, discussion of the morphology of grasses. The author also includes a discussion of the variety of grass habitats in Illinois. The key to the genera of *Grasses* is illustrated and would serve novice agrostologists well. Each subfamily, tribe and genus has a brief description, which is followed by species descriptions. Each species description includes only the most important features for identification and is written from observations of Illinois material. Also included are common name, habitat, geographic range, Illinois distribution and any pertinent taxonomic information. Following each species name is date and place of publication, synonyms, if applicable, and is cross-referenced with an accompanying illustration.

The *Sedges* volume covers all genera of Cyperaceae except *Carex*. The *Sedges* bears many similarities to the *Grasses* volume. Like *Grasses*, the introduction provides a short and informative discussion on the morphology and distribution of sedges. Mohlenbrock also discusses the relationship of sedges to other monocot families and describes how sedges are classified. The taxonomic treatment includes an illustrated key to genera and brief descriptions of tribes and genera. Species descriptions follow the same format found in the *Grasses* text. The appendix that follows clearly details additions and nomenclature changes to the Illinois flora. Many species of *Scirpus*, for example, have been transferred to segregate genera, including *Isolepis*, *Bulboschoenus* and *Schoenoplectus*.

The new *Flowering Plants* edition includes taxa from the Chenopodiales: Phytolaccaceae,

Nyctaginaceae, Molluginaceae, Cactaceae, Portulacaceae, Chenopodiaceae, Amaranthaceae and Caryophyllaceae. Polygonaceae, a family included in this order, is treated in a previous volume. The *Flowering Plants* volume does not include a key to the families at the beginning of the taxonomic treatment, but it would have been useful. Instead, readers are encouraged to use Mohlenbrock's companion book *Guide to the Vascular Flora of Illinois*. After a five page introduction, the *Flowering Plants* volume delves into the Chenopodiales. Species descriptions are provided in an identical structure as the other volumes. Moreover, the author provides other useful tidbits such as a key to sterile or immature specimens of genera in the Chenopodiaceae and a table that details the differences between *Chenopodium lanceolatum* and *C. album*. The illustrations in this volume are truly lovely and I found myself admiring them as I paged through the text. Never have I seen such weedy species presented in such a lovely fashion.

The information included in these three texts is an invaluable addition to the knowledge of the flora of North America. In particular, those interested in the Midwest United States should consider making this series a part of their library.—*Amy Trauth Nare, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A. amy trauth@yahoo.com*

JOHN A. PARROTTA. 2002. **Healing Plants of Peninsular India.** (ISBN 0-85199 501-2, hbk.). CABI Publishing, 10 East 40th Street, Suite 3203, New York, NY 10016, U.S.A. (Orders: 212-481-7018, 212-686-7993 fax, cabi-nao@cabi.org). $140.00, 944 pp, numerous color photos, 7" × 9 1/2".

Healing Plants of Peninsula India is an important addition to the therapeutic plant knowledge base. This work compiles valuable information on 545 species of therapeutic plants used in traditional Indian medicine. This is NOT a flora or identification guide, as there are no keys to species. There are, however, superb descriptions and color photographs for all species. "Species are organized alphabetically, by family, genus, and species", and all species are listed, under the appropriate family, in the table of contents.

The introductory material consists of a general introduction that addresses ecological and conservation issues, and the importance of this book in introducing readers to the medicinally useful floristic wealth of central and southern India. It is the author's hope that "...this work will contribute to the recognition and appreciation of the knowledge of plants and their therapeutic uses accumulated and preserved over the centuries across India's varied cultural landscape, and encourage efforts to conserve the diversity of natural ecosystems that are India's traditional pharmacy." There is a short section on the cultural and historical roots of traditional Indian medicine, highlighting Ayurvedic and Siddha medical concepts, and the importance of traditional medicine to the cultures of the region. There is an interesting section of only a few paragraphs called: *Botanical identification of traditional plant drug sources: current challenges*. This section describes a major problem facing Indian traditional medicine generated by a lack of precise botanical descriptions in the traditional texts and general lack of expertise in plant identification among the majority of traders, pharmacists, and Ayurvedic practitioners. A section on the *forest wealth of peninsular India* is the largest section of the introduction, and describes the region in detail, with specific information on vegetation zones. The species descriptions start soon after a brief section on *preparation and organization of the book*.

Each of the 545 species descriptions contains at least one color photograph. Descriptions are arranged as follows: The *scientific name* is followed by a listing of *synonyms* and *authorities*. *Common names* are listed in the appropriate languages of the region. Some common languages seen are: Bengali, Hindi, Sanskrit, Tamil, Kannada, and English. This feature makes this volume useful for Indian traditional healers and botanists alike, as the common names known by the locals can be used

to help find a good botanical description, with correct scientific nomenclature. *Botanical descriptions* are thorough, as is information on *distribution* and *habitat*. Of course the real importance of a work like this is best revealed under the subheading *medicinal properties and uses*. Here, one can find information on the part of the plant used in preparation of a traditional drug, historical information on which cultural groups used the plant, and the chemically active components, if they are identified. Each description also has a short list of *references*.

An extensive 186 pages of end matter follows the descriptions. A *Bibliography* is followed by a *Glossary of Medical Terms* and a *Glossary of Botanical Terms*. A very well done and complete *Common Name Index* comes next, separated into the languages of the region. Also included are a *Scientific Name Index* and an *Index of Medicinal Uses*.

This is certainly one of the most extensive and well-designed medicinal plant books to date. Hopefully its vast information and intuitive organization will set a standard for other regional medicinal plant books. This volume should help awaken readers to the vast unexplored areas of study in medicinal plants. Many of the species described in this work have not been studied scientifically, and could be of great pharmaceutical value. Finally, this book makes one fully aware of the importance of conserving all biologically diverse areas, especially those containing useful and potentially revolutionary healing plants.—*Cole Weatherby, Dept. of Biology, Austin College, Sherman, TX 75090, and Botanical Research Institute of Texas, Fort Worth, TX 76102, U.S.A., wweatherby@austinc.edu*

STEPHEN FOSTER and CHRISTOPHER HOBBS. 2002. **Peterson Field Guide to Western Medicinal Plants and Herbs.** (ISBN 0-395-83806-1, Flexi, ISBN 0-395-83807-X, hbk.). Houghton Mifflin Company, 222 Berkeley Street, Boston, MA 02116-3764, U.S.A. (Orders: 617-351-3243, gracie_doyle@hmco.com, www.houghtonmifflinbooks.com). $22.00 (Flexi), $30.00 (hbk). 448 pp, 530 + color photos, 4 1/2" × 7 1/4".

This Peterson field guide to medicinal plants is the second by author Stephen Foster. The *Peterson Field Guide to Medicinal Plants and Herbs of Eastern and Central North America*, released in 2000, marked a sort of revolution in plant field guides. Not only did this guide allow for the identification of many plant species, using the "Peterson System", but it also provided important information on both contemporary and historical medicinal uses and toxicity. Having used field guides extensively, I have often found myself wanting more information than the descriptions had to offer. This usually meant a trip home to look the species up in my local flora and, often, another trip to the library to search for articles in the scientific literature. While I usually enjoy doing this kind of detective work, I found it fascinating to have more information available right there in the field, with the plant staring me in the face.

Initially this durably bound and covered book resembles any other field-worthy guide. I was a bit surprised to find thick glossy pages, each usually presenting at least one color photograph. This book places photographs immediately adjacent to the individual species descriptions, as other Peterson guides have done. This is a very nice feature, as it can often be frustrating flipping back and forth between descriptions and photographs. The identification system is decent. As in most Peterson botanical field guides, the species are separated into six flower color sections, followed by shrubs, trees, woody vines, ferns and fern allies, and grasses and grass-like plants. In the color-separated sections, things are also grouped by various key flower characteristics. This system requires one to thumb through practically every page until they find the section they are looking for. A table of contents at the beginning of each flower color section showing the sub-sections would be very useful, and speed

up identification. I'm sure that my copy will soon be cluttered with self-adhesive notes sticking out of my favorite sections, so this problem is fixable with a little work.

The biggest surprise came when I started reading the excellent descriptions this book offers. Each species has a short botanical description, followed by range, uses, and related species and warnings when applicable. The "uses" section is, of course, the most significant thing this book has to offer. This usually presents information on how the plant was used historically, and how the plant was and is prepared. It is interesting to see so much preparation information. Although it states plainly in the introduction that this "...book is not intended to be prescriptive or to take the place of a healthcare provider...", there is certainly enough information here on preparation and indications for use to allow one to actually use these plants. Co-author Christopher Hobbs is a licensed acupuncturist, herbalist, and consultant to the dietary supplement industry whose expertise on preparing these plants for actual use is apparent upon reading these sections. Dosage information is rarely listed in the *Uses* section, which seems potentially hazardous. This work provides readers with the necessary information to make use of these plants by containing detailed preparation instructions, and then neglects to give any dosage information, not even warnings about over-dose. It is likely that it would have been difficult to compile this information, and liability issues may have also prevented the inclusion of dosages. It would also be helpful to provide references for the specific historical information presented in the text. However, there is a nice list of references in the back, which seems to compensate for this.

Icons are used throughout this book to indicate poisonous plants, plants that are known to cause allergic reactions or contact dermatitis, and those used in modern medicine. The end matter includes a checklist of plant species, with blanks to write observed flowering or fruiting dates, and two indices: an index of plant species by common and scientific name, and another of medicinal topics. The medicinal topics index is excellent, providing page numbers of plant descriptions organized by their usefulness in treating specific medical conditions.

This guide is an incomparable field companion for anyone with an interest in medicinal plants. The extensive color photographs are good to spectacular, and it is obvious that great amounts of time were invested in finding some of the best photographs available. The book's identification material, detailed information on plant uses, and brilliant color photographs make it especially deserving of a spot in your backpack.—*Cole Weatherby, Dept. of Biology, Austin College, Sherman, TX 75090, and Botanical Research Institute of Texas, Fort Worth, TX 76102, U.S.A., wweatherby@austinc.edu*

Books Received/Notices

Annotations and comments by the Editor

Timber Press' Gardener's Guide to Growing

Michael Jefferson-Brown and Harris Howland. 2002. **Gardener's Guide to Growing Lilies.** (ISBN 0-88192-537-3, pbk.; 0-88192-315-X, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $29.95 (hbk, 1995), $19.95 (pbk, 2002), 160 pp., 70 color photos, 40 b/w line drawings, 7" × 9 1/2".

Key Words: Lilies, *Lilium*, related plants, gardening, identification.

Diana Grenfell. 2002. **The Gardener's guide to Growing Daylilies.** (ISBN 0-88192-536-5, pbk.; 0-88192-461-X, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $29.95 (hbk, 1998), $19.95 (pbk, 2002), 160 pp., 74 color photos, 5 line drawings, 7" × 9 1/2".

Key Words: Daylilies, *Hemerocallis*, gardening, horticulture, identification.

Martin Page. 2002. **The Gardener's Guide to Growing Peonies.** (ISBN 0-88192-535-7, pbk.; 0-88192-408-3, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $29.95 (hbk, 1997), $19.95 (pbk, 2002), 160 pp., 76 color photos, 18 b/w line drawings, 7" × 9 1/2".

Key Words: Peonies, gardening, horticulture, identification, 600 species and cultivars.

Graham Rice and Elizabeth Strangman. 2001. **The Gardener's Guide to Growing Hellebores.** (ISBN 0-88192-517-9, pbk.; 0-88192-266-8, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $29.95 (hbk, 1993), $19.95 (pbk, 2001), 160 pp., 74 color photos, 20 line drawings, 7" × 9 1/2".

Key Words: Hellebores, gardening, horticulture, identification.

Geoff Stebbings. 2001. **The Gardener's Guide to Growing Irises.** (ISBN 0-88192-519-5, pbk.; 0-88192-388-5, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timber

press.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $29.95 (hbk, 1997), $19.95 (pbk, 2001), 160 pp., 74 color photos, 3 line drawings, 7" × 9 1/2".

KEY WORDS: Irises, gardening, horticulture, identification, cultivars.

DIANA GRENFELL. 2001. **The Gardener's Guide to Growing Hostas.** (ISBN 0-88192-518-7, pbk.; 0-88192-355-9, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $29.95 (hbk, 1996), $19.95 (pbk, 2001), 160 pp., 74 color photos, 5 line drawings, 7" × 9 1/2".

KEY WORDS: Hostas, gardening, horticulture, identification, cultivars, propagation, over 400 cultivars and forms.

Ecology/Conservation/Landscape Ecology

ROBERT H. ROBICHAUX and DAVID A. YETMAN (eds.). 2000. **The Tropical Deciduous Forest of Alamos: Biodiversity of a Threatened Ecosystem in Mexico.** (ISBN 0-8165-1922-6, hbk.). The University of Arizona Press, 355 S. Euclid, Ste. 103, Tucson, AZ 85719, U.S.A. (Orders: 520-621-1441, 520-621-8899 fax). $50.00 (hbk), 259 pp., numerous b/w photos, 6" × 9".

KEY WORDS: Mexico, Sonora, Biological diversity, tropical deciduous forest, vegetation, flora, checklist of Rio Cuchujaqui plants, trees in southern Sonora, trees of the Mayo Region, ethnobotanically useful trees, columnar cacti, Mayo people, crop diversity, amphibians and reptiles, birds.

BARBARA TELLMAN (ed.). 2002. **Invasive Exotic Species in the Sonoran Region .** (ISBN 0-8165-2178-6, hbk.). The University of Arizona Press, 355 S. Euclid, Ste. 103, Tucson, AZ 85719, U.S.A. (Orders: 520-621-1441, 520-621-8899 fax). $75.00 (hbk), 460 pp., 37 illustrations, 6 1/8" × 9 1/4".

KEY WORDS: Invasive plants, exotics, amphibians, mammals, insects, fish, birds, 500 naturalized exotic species, Sonoran Desert, adjacent grasslands, riparian areas, native landscapes, Mexico, U.S.A., environmental concerns.

RODNEY W. BOVEY. **Woody Plants and Woody Plant Management: Ecology, Safety, and Environmental Impact.** (ISBN 0-8247-0438-, hbk.). Marcel Dekker, Inc., 270 Madison Avenue, New York, NY 10016, U.S.A. (Orders: 212-696-9000, 212-685-4540 fax, www.deeker.com). Marcel Dekker AG, Hutgasse 4, Postfach 812, CH-4001 Basel, Switzerland (Orders: 41-61-261-8482, 41-61-261-8896 fax) $195.00, 564 pp., 6" × 9".

KEY WORDS: Woody plants, woody plant management.

From the back cover: "Consolidating an extensive breadth of resources on woody plants, this reference/text on the historical significance and botanical nature of woody plants details strategies for managing woody plants and using research data to select the most appropriate control methods—analyzing the responses of over 370 North American woody plants to commercially available herbicides."

Ethnobotanical/Economic/Medicinal/Useful Plants/Toxic

MARLA R. EMERY and REBECCA J. MCLAIN (eds.). 2001. **Non-timber Forest Products: Medicinal Herbs, Fungi, Edible Fruits and Nuts, and Other Natural Products from the Forest.** (ISBN 1-56022-089-9, pbk.). Food Products Press, 10 Alice Street, Binghamton, NY 13904-1580 U.S.A. (Orders: 607-722-5857, 607-722-1424 fax, getinfo@haworthpressinc.com). Price not listed, 176 pp., 6" × 8 1/4".

KEY WORDS: Non-timber forest products, North America, review, history, sustainable uses.

NARAYAN P. MANANDHAR. 2002. **Plants and People of Nepal.** (ISBN 0-88192-527-6). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $69.95, 636 pp., 48 color photos, 3 tables, 834 line drawings, 2 maps, 8 1/2" × 11".

Key Words: Plants, Nepalese people, flora, ethnobotany, descriptions, common names.

This is quite a book with fantastic color photos of plants and Nepalese people. There are no keys so the drawings, although not sophisticated, are excellent aids in identification. What a great reference with several useful appendices.

Science/Society/Economy

DOROTHY SCHWIEDER, THOMAS MORAIN, and LYNN NIELSEN. 2002. **Iowa Past to Present: The people and the Prairie. Third edition.** (ISBN 0-8138-2998-4, hbk.). Iowa State Press, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax; www.iowastatepress.com). $32.99, 312 pp., numerous b/w photos and other illustrations, 7" × 10".

KEY WORDS: Iowa, history, juvenile literature, American Indians, pioneers, prairies, settlers, frontier, farms.

STUART MCCOOK. 2002. **States of Nature. Science, Agriculture, and Environment in the Spanish Caribbean.** (ISBN 0-292-75256-3, hbk.; 0-292-75257-1, pbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (Orders: 800-252-3206 fax; 512-471-4032). $50.00 (hbk), $22.95 (pbk), 201 pp., 6 photos, 1 map, 6" × 9".

KEY WORDS: Science, history, Latin America, Caribbean, Venezuela, Puerto Rico, Colombia, Costa Rica, environment, nature, economy, agriculture, botanical science.

GERHARD SONNERT (with assistance of Gerald Holton). 2002. **Ivory Bridges: Connecting Science and Society.** (ISBN 0-262-19471-6, hbk.). The MIT Press, 5 Cambridge Center, Cambridge, MA 02142-1493, U.S.A. (Orders: 800-405-1619, mitpress-orders@mit.edu, mitpress.mit.edu). $30.00 (hbk), 227 pp., 6" × 9".

KEY WORDS: Science, society, governmental science policy, scientists' voluntary public-interest associations, "pure" science, research in the national interest, activities of citizen scientists

Botany/Molecular/Physiology

THOMAS J. GIVNISH and KENNETH J. SYTSMA. 1997. **Molecular Evolution and Adaptive Radiation.** (ISBN 1-521-57329-7, hbk.). Cambridge University Press, The Edinburgh Building, Cambridge CB2 2RU, UK; 40 West 20th Street, New York, NY 10011-4211, U.S.A. $39.95, 621 pp., b/w photos, figures, 7" × 10".

KEY WORDS: Evolution, adaptive radiation, convergence, reproductive strategies, macroevolutionary patterns.

There were forty authors who contributed to the book's seven chapters: **1)** Introduction; **2)** Integrative Studies; **3)** Convergence; **4)** Rapid Radiations; **5)** Reproductive Strategies; **6)** Character Divergence and Community Assembly; and **7)** Macroevolutionary Patterns.

R.S. SINGH. 2000. **Diseases of Fruit Crops.** (ISBN 1-57808-159-9, pbk.; 1-57808-149-1, hbk.). Science Publishers, Inc., P.O. Box 699, Enfield, NH 03748, U.S.A. (Orders: sales@scipub.net; www.scipub.net, or info@scipub.net). $49.50 (pbk), 310 pp., 31 b/w photos, 6" × 9 1/2".

KEY WORDS: Fruit diseases, fruit pests, citrus, pome and stone fruits, mango, banana, grapevines and grapes, guava, strawberry, coconut palm, pineapp.le, pomegranate, litchi, loquat, cashewnut, sapodilla plum.

GEORGE G. KHACHATOURIANS, ALAN MCHUGEN, RALPH SCORZA, WAI-KIT NIP, and Y.H. HUI (eds.). 2001. **Transgenic Plants and Crops.** (ISBN 0-8247-0545-9, hbk.). Marcel Dekker, Inc., 270 Madison Avenue, New York, NY 10016, U.S.A. (Orders: 212-696-9000, 212-685-4540 fax, www.deeker.com). Marcel Dekker AG, Hutgasse 4, Postfach 812, CH-4001 Basel, Switzerland (Orders: 41-61-261-8482, 41-61 261-8896 fax) $225.00, 876 pp., b/w photos, 7" × 10".

KEY WORDS: Transgenic plants, crops, transgenic techniques, agriculture, molecular biology, food plant biotechnology, genetics, social, political, legal aspects of genetic plant manipulation.

YOAV WAISEL, AMRAM ESHEL, and UZI KAFKAFI (eds.). 2002. **Plant Roots. The Hidden Half. Third Edition.** (ISBN 0-8247-0631-5, hbk.). Marcel Dekker, Inc., 270 Madison Avenue, New York, NY 10016, U.S.A. (Orders: 212-696-9000, 212-685-4540 fax, www.deeker.com). Marcel Dekker AG, Hutgasse 4, Postfach 812, CH-4001 Basel, Switzerland (Orders: 41-61-261-8482, 41-61-261-8896 fax) $250.00, 1120 pp., color and b/w photos, line drawings, 8 1/2" × 11".

KEY WORDS: Roots, characteristics of roots, root system, root structure, development, root genetics, regulation of root growth, physiological aspects of root systems, roots under stress, roots of various ecological groups, roots of economic value, roots with medicinal activity

This is quite a book on the subject of roots. There are some 99 individuals listed as contributing to this incredible and massive compilation. The references follow each of the 59 chapters rather than at the end. The editors are to be congratulated.

ANDRÉ O. BAREL, MARC POAYE, and HOWARD I. MAIBACH (eds). **Handbook of Cosmetic Science and Technology.** (ISBN 0-8247-0292-1, hbk.). Marcel Dekker, Inc., 270 Madison Avenue, New York, NY 10016, U.S.A. (Orders: 212-696-9000, 212-685-4540 fax, www.deeker.com). Marcel Dekker AG, Hutgasse 4, Postfach 812, CH-4001 Basel, Switzerland (Orders: 41-61-261-8482, 41-61-261-8896 fax) $235.00, 886 pp., b/w photos, and other figures, 7" × 10".

KEY WORDS: Cosmetics, cosmetic ingredients, finished products, target organs, delivery systems, current technology in safety, toxicology, dermatological testing.

This appears to be an up-to-date reference on the cosmetic industry. **Part 1)** Introduction; **Part 2)** Target Organs for Cosmetic Products; **Part 3)** Safety Considerations; **Part 4)** Vehicles of Cosmetic Products; **Part 5)** Cosmetic Ingredients; **Part 6)** Cosmetic Products; **Part 7)** Legislation and Regulations Worldwide; **Part 8)** Testing Cosmetic Products; and **Part 9)** Cosmetic Claims. Contributions from some 92 expert scientists from academic dermatology and dermato-cosmetics, the cosmetics industry, ingredients and raw materials producers, to regulatory agencies, helped the editors to achieve their goal.

MOHAMMAD PESSARAKLI (ed). **Handbook of Plant and Crop Physiology.** (ISBN 0-8247-0546-7, hbk.). Marcel Dekker, Inc., 270 Madison Avenue, New York, NY 10016, U.S.A. (Orders: 212-696-9000, 212-685-4540 fax, www.deeker.com). Marcel Dekker AG, Hutgasse 4, Postfach 812, CH-4001 Basel, Switzerland (Orders: 41-61-261-8482, 41-61-261-8896 fax) $225.00, 973 pp., b/w photos, graphs, and other figures, 7" × 10".

KEY WORDS: Plant crops, physiology, environmental factors, climatic changes, developmental states, growth regulators.

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Biographical

WILFRID BLUNT (Introduction by William T. Stearn). 2001. **Linnaeus: The Compleat Naturalist.** (ISBN 0-691-09636-8, pbk.). Princeton University Press, 41 William Street, Pinceton, NJ 08540, U.S.A. (Orders: California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A., 609-883-1759, 609-883-7413 fax, www.pup.princeton.edu). $35.00, 264 pp., color photos, 7 3/4" × 9 3/4".

KEY WORDS: Linnaeus, biography, taxonomy, systematic botany, history.

Journals

Acta Botanica Hungarica. (ISSN 0236-6495). Akadémiai Kiadó, Budapest, H-1519 Budapest, P.O. Box 245, HUNGARY. (Subscriptions: 36-1-464-8221, email: kiss.s@akkrt.hu). $192.00, 4 issues/year, 6 1/2" × 9 1/2".

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NEW AND NOTEWORTHY ORCHIDS OF THE BISMARCK ARCHIPELAGO, PAPUA NEW GUINEA

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ABSTRACT

A general account is provided of the orchid gatherings from the 1994 Conservation International survey of southern New Ireland, an area identified by environmental assessment as one of Papua New Guinea's major terrestrial unknown regions. One new species (*Dendrobium archipelagense*) and one new variety (*Dendrobium vexillarius* J.J. Sm. var. *hansmeyerense*) are described and illustrated. Several distributional records are reported. Illustrations are provided for most of the cited taxa.

KEY WORDS: Botanical survey, *Dendrobium*, New Ireland, Orchidaceae, Papua New Guinea

JAPANESE ABSTRACT

パプアニューギニアの中でも最も生態的調査が遅れている地域といわれる、ニューアイルランド島南部において、1994年にコンザベーションインターナショナルによる調査が行われた。この調査において採集された蘭に関する報告を行う。*Dendrobium archipelagense* と *D. vexillarius* J.J. Sm. var. *hansmeyerense* の2つの新種の蘭の形態に関して記述と図説を行い、幾つかの分布地域に関しても報告する。

INTRODUCTION

Originally a part of the German Territory of New Guinea, the Bismarck Archipelago consists primarily of New Britain, New Ireland, and Manus. These islands are now separate provinces of the sovereign state of Papua New Guinea (PNG). The Archipelago is collectively designated as the 'Islands Region' by national administrators, and also includes several minor islets scattered outboard of New Ireland, as for example, the St. Matthias group, Lihir, and Tabar (Fig. 1).

The Bismarck Archipelago represents one of PNG's most poorly documented floristic regions (Takeuchi & Golman 2001). It is unfortunately the most intensively logged territory in the country: 50% of the archipelagic land area is currently under timber concessional development (ibid.). Because of the paucity of biodiversity information, the forested tracts in southern New Ireland are ranked among PNG's 16 terrestrial unknowns and are also included in the country portfolio of high-priority sites for conservation action (Johns 1993: 25; Sekhran & Miller 1995: 113–15).

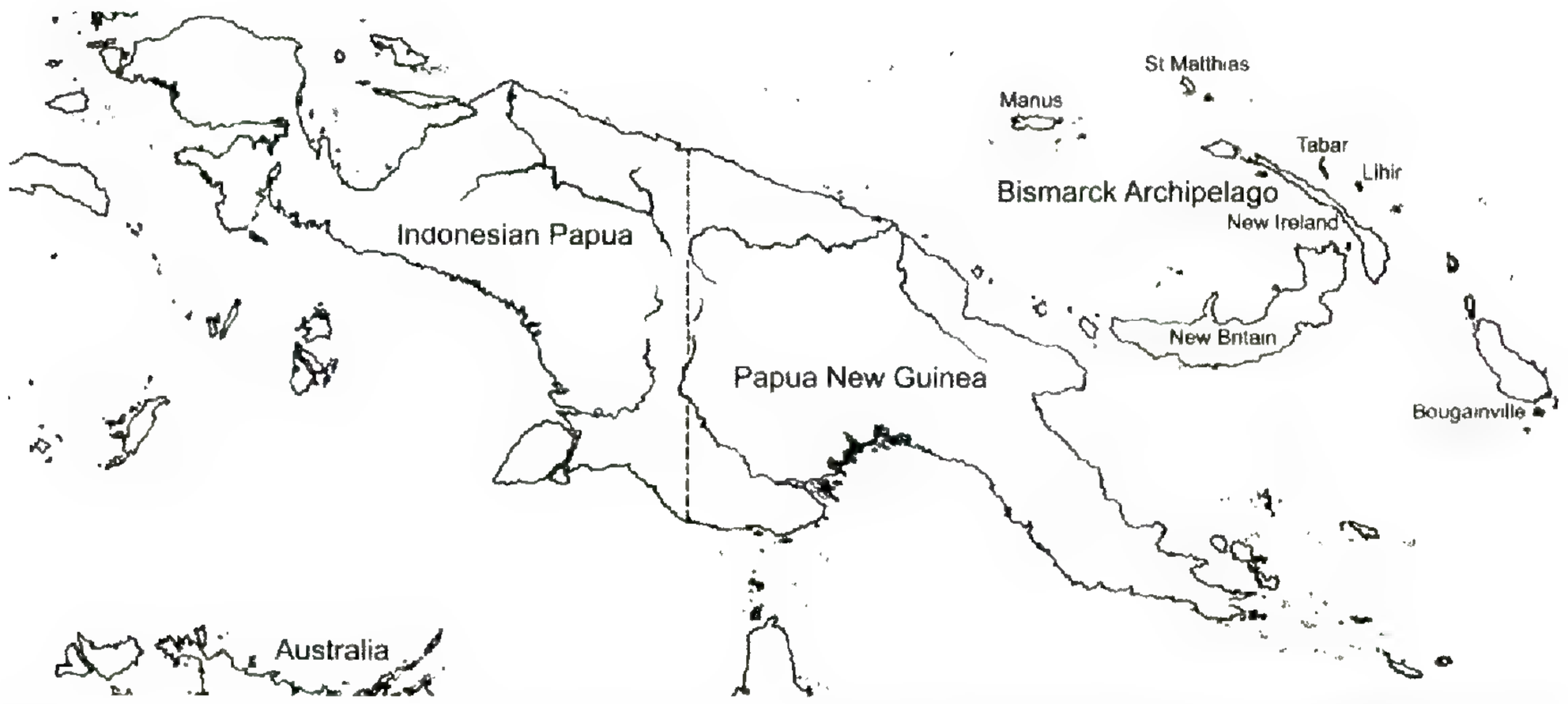


FIG. 1. Island of New Guinea, and the Bismarck Archipelago.

In order to assess the status of its environments, from January 14 to February 16, 1994, a 13-member team conducted an elevation-sequenced survey in the Weitin Valley and Hans Meyer Range of southern New Ireland. Although the survey's collective findings have been recently published (Beehler & Alonso 2001), the orchid vouchers were treated in a separate checklist (Howcroft 1994). In the following discussion, the orchids from the 1994 survey are given further consideration. Occurrence notes from other areas within the Archipelago have also been added when appropriate.

DESCRIPTIONS OF NEW TAXA

Dendrobium vexillarius J.J. Sm. var. **hansmeyerense** Howcroft & Takeuchi, var. nov. (**Fig. 2**). TYPE: PAPUA NEW GUINEA. NEW IRELAND PROVINCE: Hans Meyer Range, Angil Mountain, expedition camp 4 in pristine subcloud forest, 4°25.2' S, 152°56.8' E, 1800 m, 6 Feb 1994 (fl, fr, spirit), *W. Takeuchi & J. Wiakabu* 9453 (HOLOTYPE: LAE).

A var. *vexillarius* sepalis latioribusque abaxialis cristatus differt.

Distribution and ecology.—Known thus far only from the type locality, in mossy montane forest at 1800 m.

Etymology.—The new variety is named after the type locality.

Dendrobium vexillarius was previously represented by six varieties separated primarily by the color of the perianth (Reeve & Woods 1989: 250). A prominent abaxial crest on the lateral sepals distinguishes var. *hansmeyerense* from other infraspecific taxa.

The new variety was collected earlier during the 1975 Kew expedition to New Ireland (i.e., *Sands et al. 1985, 2349, 2374, 2399*). Reeve and Woods (1990) had tentatively assigned these specimens to variety *uncinatum*. However that variety is not prominently crested on the abaxial side of the lateral sepals as with var. *hansmeyerense*. Keels are sometimes present among the varieties of *D.*

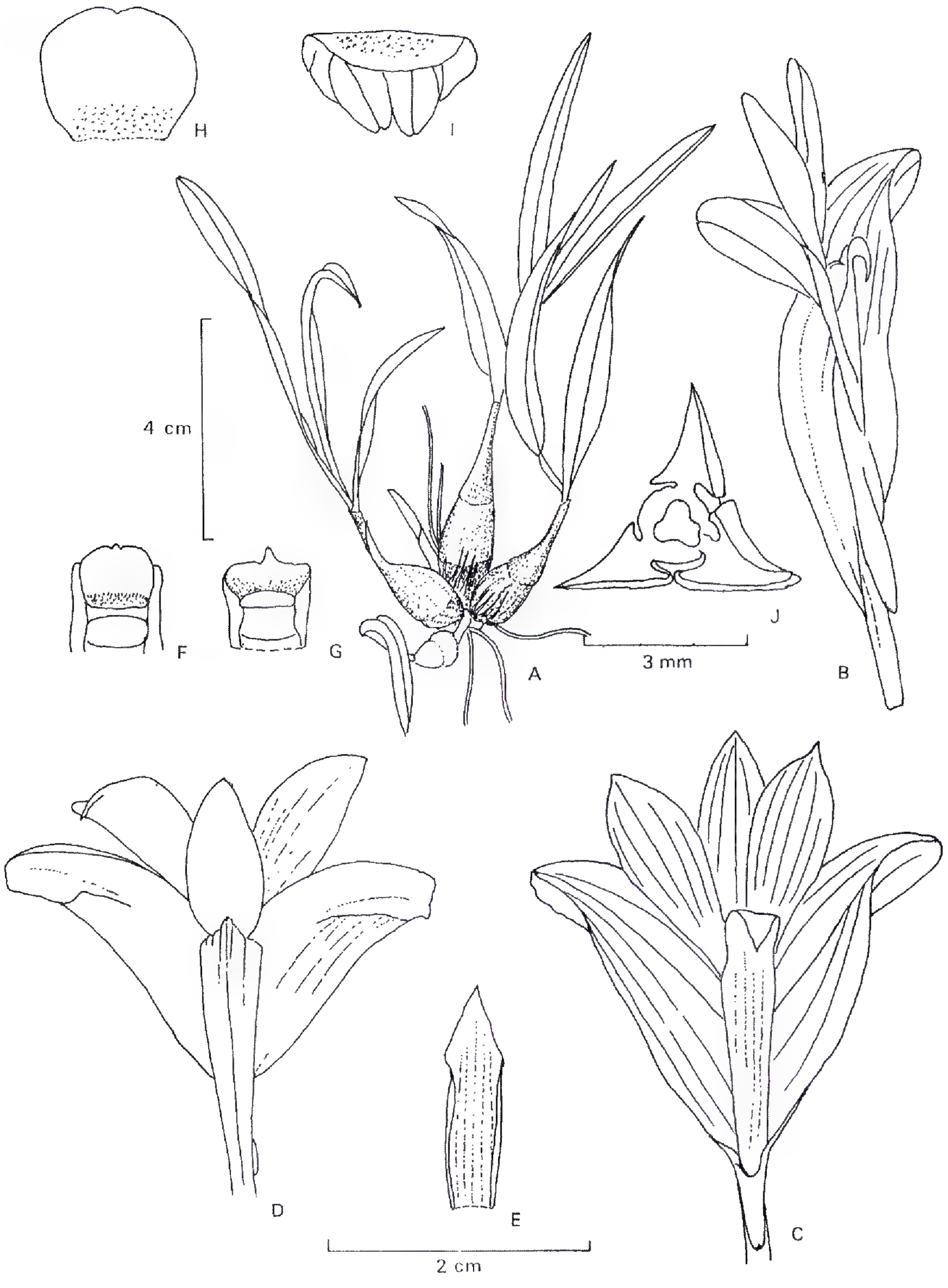


FIG. 2. *Dendrobium vexillarius* J.J. Sm. var. *hansmeyerense* Howcroft & Takeuchi. **A.** Habit. **B.** Flower, side view. **C.** Flower, from below. **D.** Flower, from above. **E.** Labellum, midsection to apex. **F–G.** Column apex with and (**G**) without anther. **H.** Anther, front view. **I.** Anther with pollen, oblique rear (or anterior) view. **J.** Ovary in cross-section. Scale bars: A, 4 cm; B–E, 2 cm; F–G, 3mm; H–I (enlarged 30×); J, 3mm. Drawn from the type by N.H.S. Howcroft.

vexillarius but they are not prominent. The only other taxon in this section with a prominent abaxial keel is *D. brevicaule* Rolfe ssp. *pentagonum* (Kraenzlin) Reeve & Woods, with an otherwise very differently shaped ovary in cross-sectional view.

Dendrobium archipelagense Howcroft & Takeuchi, sp. nov. (**Fig. 3**). TYPE: PAPUA NEW GUINEA. NEW IRELAND PROVINCE: junction of Niagara and Weitin rivers, expedition camp 2, lowland rainforest, 4°30.210' S, 152°56.242' E, 240 m, Jan 1994 (fl, spirit), *W. Takeuchi & J. Wiakabu 9979* (HOLOTYPE: LAE; ISOTYPE: A)

Dendrobio strepsiceroti J.J.Smith, *Dendrobio antennato* Lindley affinis sed differt forma ac amplitudine labelli, lobis lateralibus oblongi-ellipticis (non quadrati ellipticis) apicibus rotundatis superpositis basim midlobi, et lamella triangulari carenti in parte distali midlobo.

Tufted epiphyte. **Rhizomes** short. **Pseudobulbs** swollen at the base, fusiform in the lower part, distally more slender, subcylindrical, with persistent nodal sheaths shorter than the internodes, leafy, to 50 by 1.0–2.0 cm. **Leaves** distichous, lanceolate-ovate, 7.5–9.5 by 2.0–3.0 cm, asymmetrically emarginate, adaxially slightly concave, abaxially convex, thick, coriaceous, green to yellow-green. **Inflorescence** racemose, one or several per pseudobulb, inserted at the apex or slightly below, erect, rachis to 40 cm by 2 3 mm; peduncle to 9 cm long, peduncular and floral bracts tubular; pedicel glabrous, ca. 2.2 cm long. **Flowers** 5–10 per raceme, usually wide-opening, 4.0–5.5 by 3.5 cm, pale green to yellow-green. **Dorsal sepal** recurved, twisted through one turn, oblong-lanceolate, 2.0–2.6 by 0.6–0.7 cm, acuminate. **Lateral sepals** recurved, oblong-lanceolate, 2.5–3.3 by 0.9 cm at the base, apex acute or acuminate. **Mentum** narrowly conical, 0.9–1.0 cm long, apex straight or slightly decurved. **Petals** linear, acute, 3.0–4.5 by 0.25–0.4 cm, twisted through one or two turns, spreading. **Labellum** porrect, 3-lobed, 2.0–2.3 by 1.0–1.5 cm, similar in color to sepals and petals but with some purple venation; lateral lobes oblong-elliptic, 1.15 by 1.5 cm, over-lapping base of the midlobe, apex rounded; midlobe ovate, 1.0 by 1.0 cm, acute to apiculate, not recurved; callus of 5 keels, the lateral ones not extending past the base of the midlobe, the median keel extending to the apex of the midlobe, slightly raised, not lamellate or crested. **Column** 0.5 cm long, apex laterally bilobed, foot at 10° to column. **Ovary** glabrous, 0.9 cm long.

Distribution and ecology.—Widely distributed throughout the Bismarck Archipelago, frequently on trees near the coast but also from inland areas. The type locality is lowland rainforest at 240 m.

The new species seems to flower mainly during the first half of each year. In addition to the type specimen (flowering in Jan), cultivated plants have produced flowers continuously from May to Jul. Seeds from the previous year's set, are released simultaneously with the production of new flowers.

Etymology.—The epithet reflects the distributional restriction to the Bismarck Archipelago.

Within section *Spatulata* Lindl., the novelty's closest relative appears to be

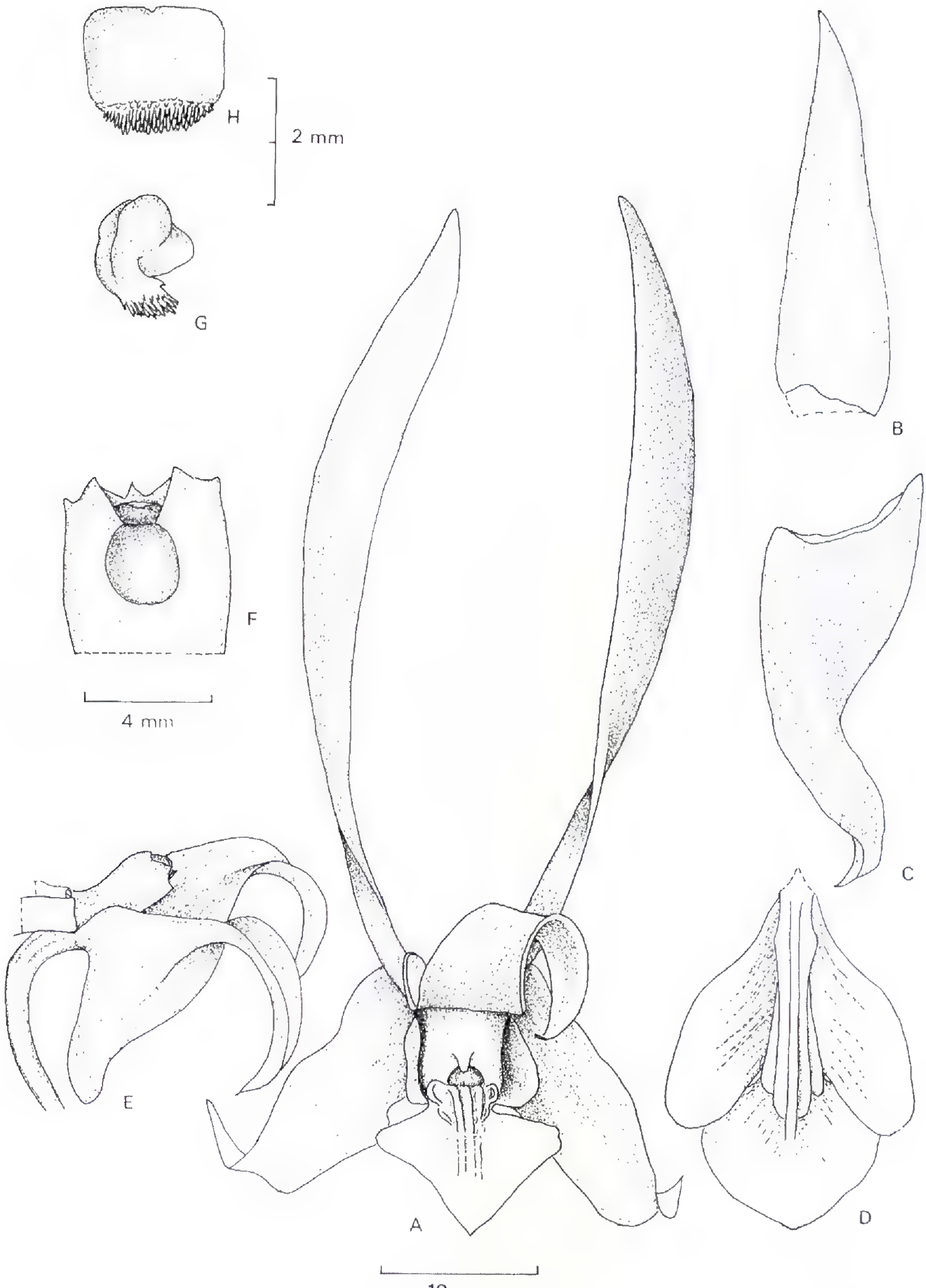


FIG. 3. *Dendrobium archipelagense* Howcroft & Takeuchi. **A.** Flower, aspect. **B.** Dorsal sepal. **C.** Lateral sepal. **D.** Labellum. **E.** Spur, with lateral sepals and column. **F.** Column apex with stigma, from below. **G.** Anther, lateral view. **H.** Anther, frontal view. Scale bars: A–E, 10 mm; F, 4 mm; G–H, 2 mm. Drawn from the type by N.H.S. Howcroft.

Dendrobium antennatum Lindl. In his treatment of this section, Cribb (1986: 618) recognized several species groups, among them the *antennatum* group with 9 species. The new species was formerly placed in *D. strepsiceros* J.J. Sm. by Cribb (ibid.: 637), O'Byrne (1994: 236), and Lavarack et al. (2000: 262).

Smith's illustration of *D. strepsiceros* (1913: Fig. 4, B1, B2) shows that its labellum differs from the corresponding characters in the new species. In *D. strepsiceros* the labellum midlobe is larger than the lateral lobes, and the apices of the latter do not overlap the base of the midlobe as it does in live specimens of *D. archipelagense* (Fig. 3). This distinction can be lost in the preparation of dried specimens so the relationship between the lobes is best seen with spirit material. Apart from the difference in shape and extension of the lateral lobes, *D. archipelagense* has a shorter labellum compared to *D. strepsiceros* and is more similar to *D. antennatum* on that feature.

Compared to its closest congeners, the lateral lobes of the new species are proportionately larger in relation to the length of the labellum. In *D. archipelagense*, the lateral lobe is 70–80% of the labellum length, in *D. antennatum* 55–70%, and in *D. strepsiceros* 50–58% (Fig. 4).

There are five ridges on the callus of the labellum in all of the preceding species. The mid-callus ridge for *D. archipelagense* extends towards the apex of the midlobe, but is not raised to a triangular lamella as described for *D. strepsiceros*. This character may have been overlooked by other authors.

The new species has long petals which make the flower appear larger than typical *D. antennatum*. As many as ten flowers can be produced by one inflorescence. The color of the perianth is initially light green but turns yellow-green with age. In most individuals, the ridges of the labellum are bordered with violet, and there are also violet reticulations up to the median, and sometimes the distal portion of the midlobe. The perianth is persistent on the fruit, a characteristic shared by other species in the *antennatum* group.

No significant color differences have been seen between specimens from West New Britain, East New Britain, and New Ireland. However in terms of flower size, the type collection represents one of the largest and most attractive forms seen by the senior author.

DISTRIBUTIONAL RECORDS

Arachnis beccarii Reichb. f. var. **imthurnii** (Rolfe) Tan, Selbyana 1:1–15. 1975; 1:365–373. 1976. (**Fig. 5**).

Specimen examined: **PAPUA NEW GUINEA. New Ireland Province:** junction of Niagara and Weitin rivers, expedition camp 2, lowland rainforest, 4°30.210' S, 152°56.242' E, 240 m, Jan 1994 (fl, spirit), *W. Takeuchi & J. Wiakabu 9968* (LAE).

The genus *Arachnis* is represented by two species in New Guinea, of which only *A. beccarii* occurs in the Bismarck Archipelago.

Variety *imthurnii* had been previously recorded from Bougainville,

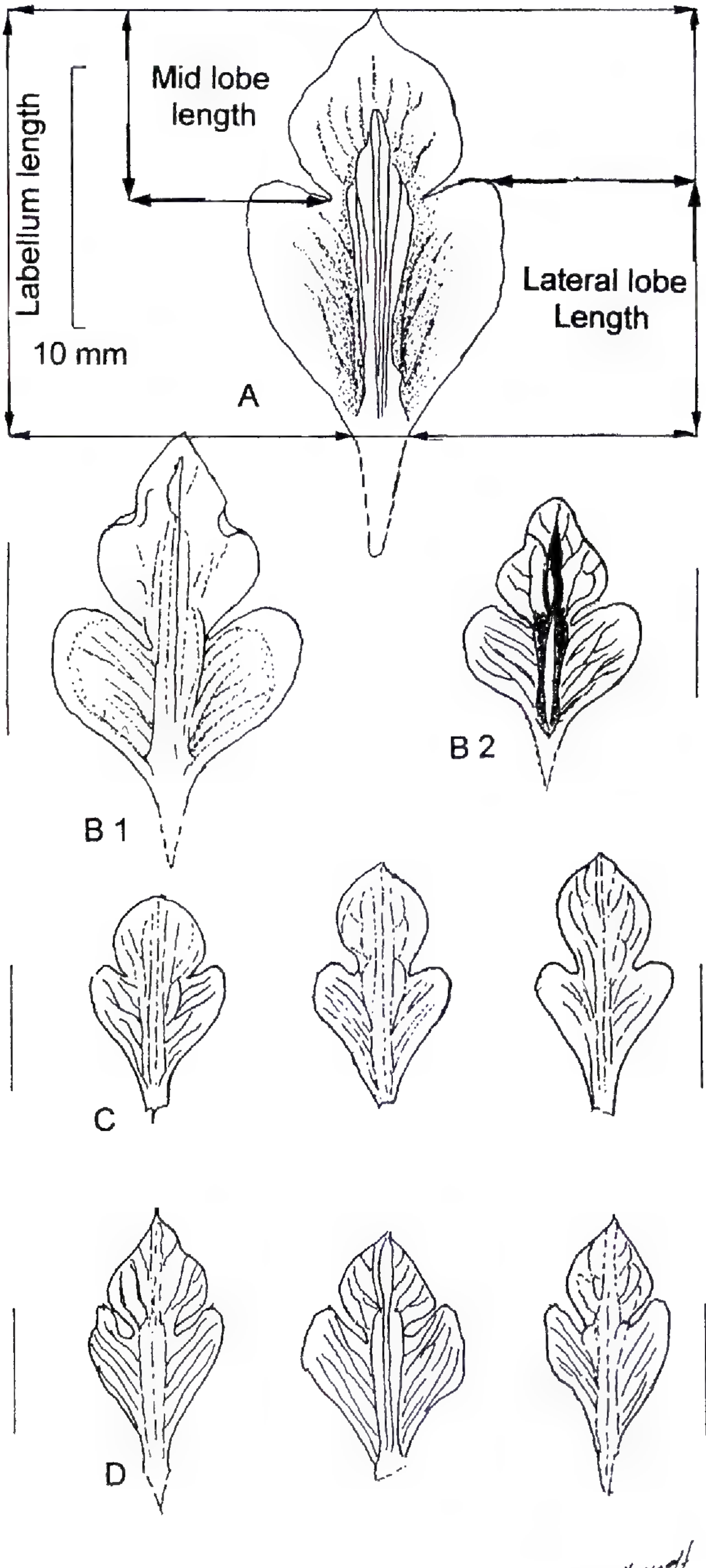


FIG. 4. **A.** Labellum structure. **B1.** *Dendrobium strepsiceros* J.J. Sm., from Smith (1913). **B2.** *D. strepsiceros*, from Cribb (1986). **C.** *D. antennatum* Lindl. **D.** *D. archipelagense* Howcroft & Takeuchi. All scale bars: 10 mm.

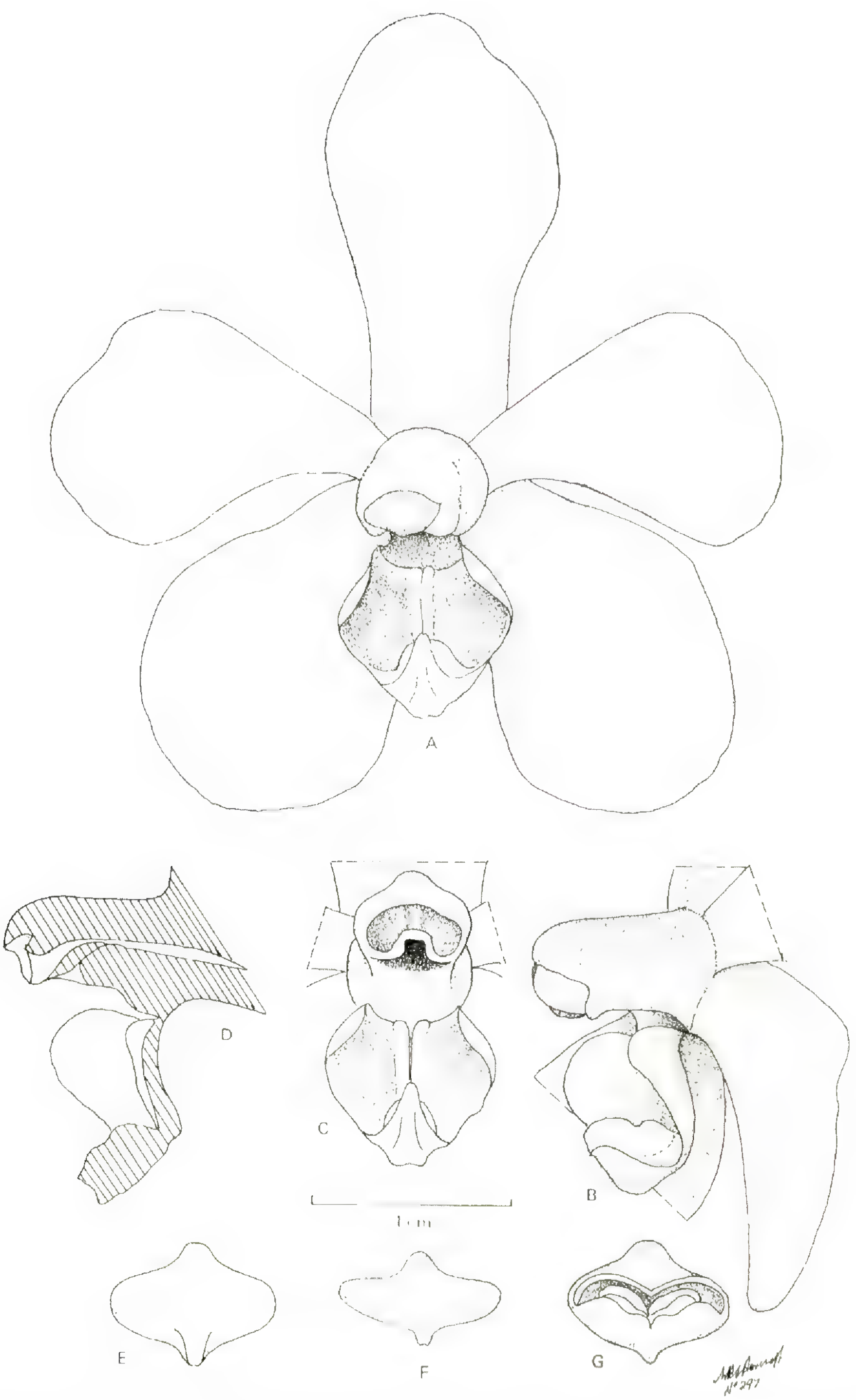


FIG. 5. *Arachnis beccarii* Reichb. f. var. *imthurnii* (Rolfe) Tan. **A.** Flower, frontal aspect. **B.** Labellum and column, side view. **C.** Labellum and column, frontal view. **D.** Labellum and column, cross-section. **E.** Anther, frontal view. **F.** Anther, from above. **G.** Anther, from back, showing pollen. Scale bars: A–G, 1 cm. Drawn from *W. Takeuchi & J. Wiakabu 9968* by N.H.S. Howcroft.

Guadalcanal, Malaita, and Santa Isabel (Lewis & Cribb 1991). It was also seen by the senior author on the Toriu River side of the Kanak Range in East New Britain. The New Ireland specimen is a distributional record for the island.

Although var. *imthurnii* is reported as having an entirely white perianth (ibid.), the New Ireland provenance is marked by large brown spots. Cultivated plants in the National Botanical Gardens at Lae have also produced flowers with color markings different from mainland and archipelagic provenances. The distinctions can be used to justify eventual reinstatement of this variety to specific rank.

Corybas epiphyticus (J.J. Sm.) Schltr., Feddes Repert. Spec. Nov. Regni Veg. 19:21. 1923. (**Fig. 6**).

Specimen examined: **PAPUA NEW GUINEA. New Ireland Province:** Hans Meyer Range, Angil Mountain, expedition camp 4, pristine subcloud forest dominated by bryophytic and ferny growth, 4°25.2' S, 152°56.8' E, 1800 m, 6 Feb 1994 (fl, spirit), *W. Takeuchi & J. Wiakabu 9461* (LAE).

Previously known only from Indonesian Papua (van Royen 1983). The collection from New Ireland represents a significant eastward extension of the species range. *Corybas epiphyticus* is still unrecorded from the PNG mainland.

Dendrobium gnomus Ames, J. Arnold Arbor. 14:106–107. 1933. (**Fig. 7**).

Specimen examined: **PAPUA NEW GUINEA. New Ireland Province:** Hans Meyer Range, ridge adjacent to the Weitin River, expedition camp 3, mossy montane forest, 4°27.205' S, 152°56.489' E, 1175 m, 27 Jan 1994 (fl, spirit), *W. Takeuchi & J. Wiakabu 9597* (LAE).

This species was initially mistaken for *Dendrobium erosum* (Bl.) Lindl. because of the spathulate shape of the labellum and its finely erose margins (Fig. 7F). However the leaf apex is unequally bilobed as with *D. gnomus* (Fig. 7A), whereas in *D. erosum* the apex is acute. The cucullate labellum apex on the New Ireland specimen is probably an artefact of drying. The shape of the sepals and petals, and the mentum being appressed to the ovary and pedicel rather than diverging, are also consistent with the redetermination (Figs. 7B–E).

The species had not been previously recorded for New Ireland.

Pedilochilus longipes Schltr., Feddes Repert. Spec. Nov. Regni Veg. Beih. 1:691. 1912. (**Fig. 8**).

Specimen examined: **PAPUA NEW GUINEA. New Ireland Province:** Hans Meyer Range, Angil Mountain, expedition camp 4, pristine subcloud forest dominated by bryophytic and ferny growth, 4°25.2' S, 152°56.8' E, 1800 m, 4 Feb 1994 (fl), *W. Takeuchi & J. Wiakabu 9380* (LAE).

Previously known with certainty only from mainland New Guinea. The New Ireland specimen represents a distributional record.

Phaius amboinensis Bl., Mus. Bot. Lugd.-Bat. 2:180. 1856. (**Fig. 9**).

Specimen examined: **PAPUA NEW GUINEA. New Ireland Province:** junction of Niagara and Weitin rivers, expedition camp 2, lowland rainforest, 4°30.210' S, 152°56.242' E, 240–300 m, 13 Feb 1994 (fl, fr, spirit), *W. Takeuchi & J. Wiakabu 9780* (A, LAE).



FIG. 6. *Corybas epiphyticus* (J.J. Sm.) Schltr. **A.** Flower and leaf, side view. **B.** Dorsal sepal. **C.** Labellum, frontal view. **D.** Labellum, with parts flattened and spread out. **E.** Column, showing ovary and one spur. **F.** Column with labellum removed and showing two lateral spurs. Scale bars: A–D, 1 cm; E–F, 5 mm. Drawn from *W. Takeuchi & J. Wiakabu 9461* by N.H.S. Howcroft.

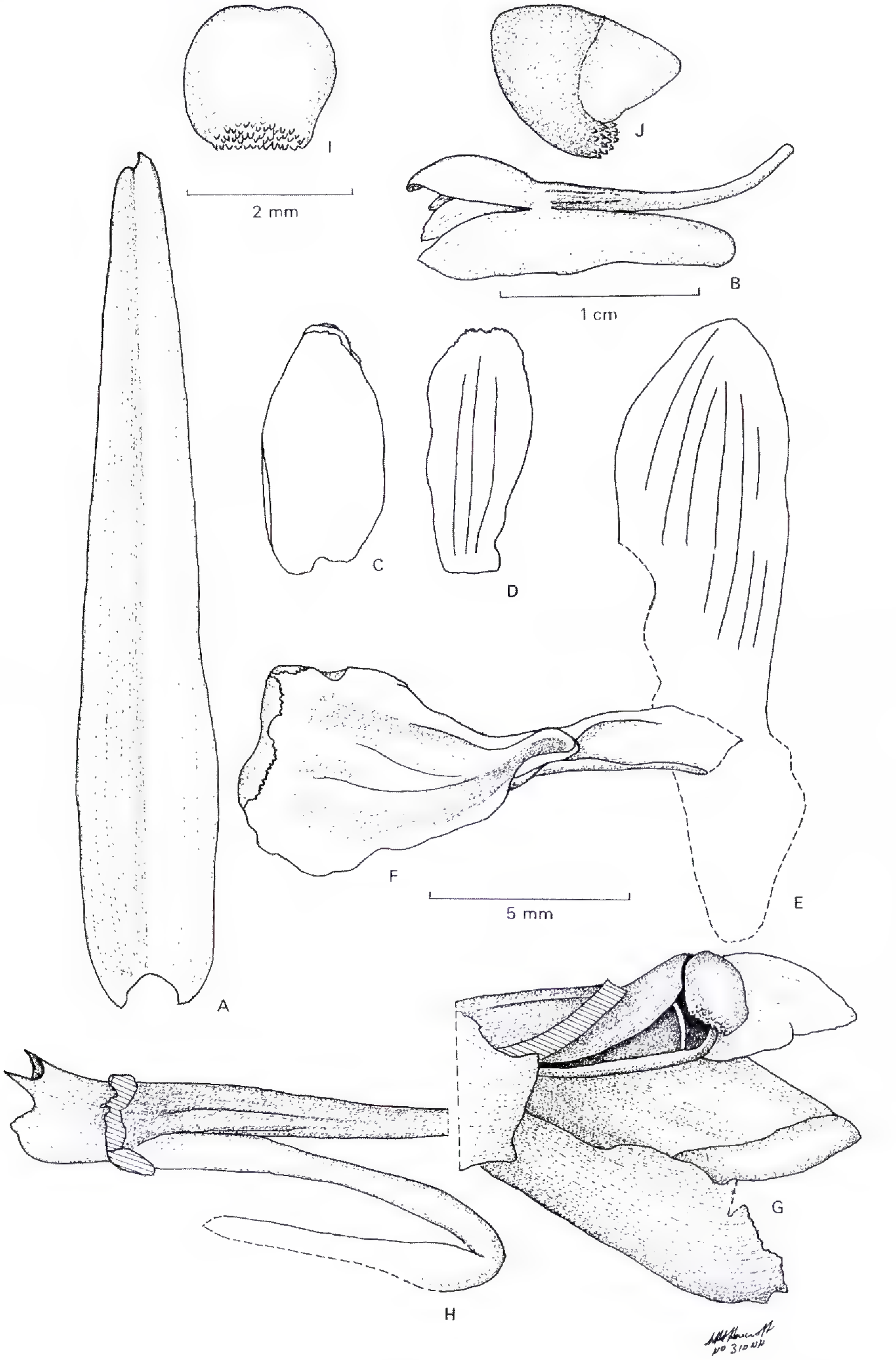


FIG. 7. *Dendrobium gnomus* Ames. **A.** Leaf. **B.** Flower, side view. **C.** Dorsal sepal. **D.** Petal. **E.** Lateral sepal. **F.** Labellum. **G.** Column, oblique side view. **H.** Column, ovary, and spur. **I.** Anther from front. **J.** Anther from side. Scale bars: A–B, 1 cm; C–H, 5 mm; I–J, 2 mm. Drawn from *W. Takeuchi & J. Wiakabu 9597* by N.H.S. Howcroft.

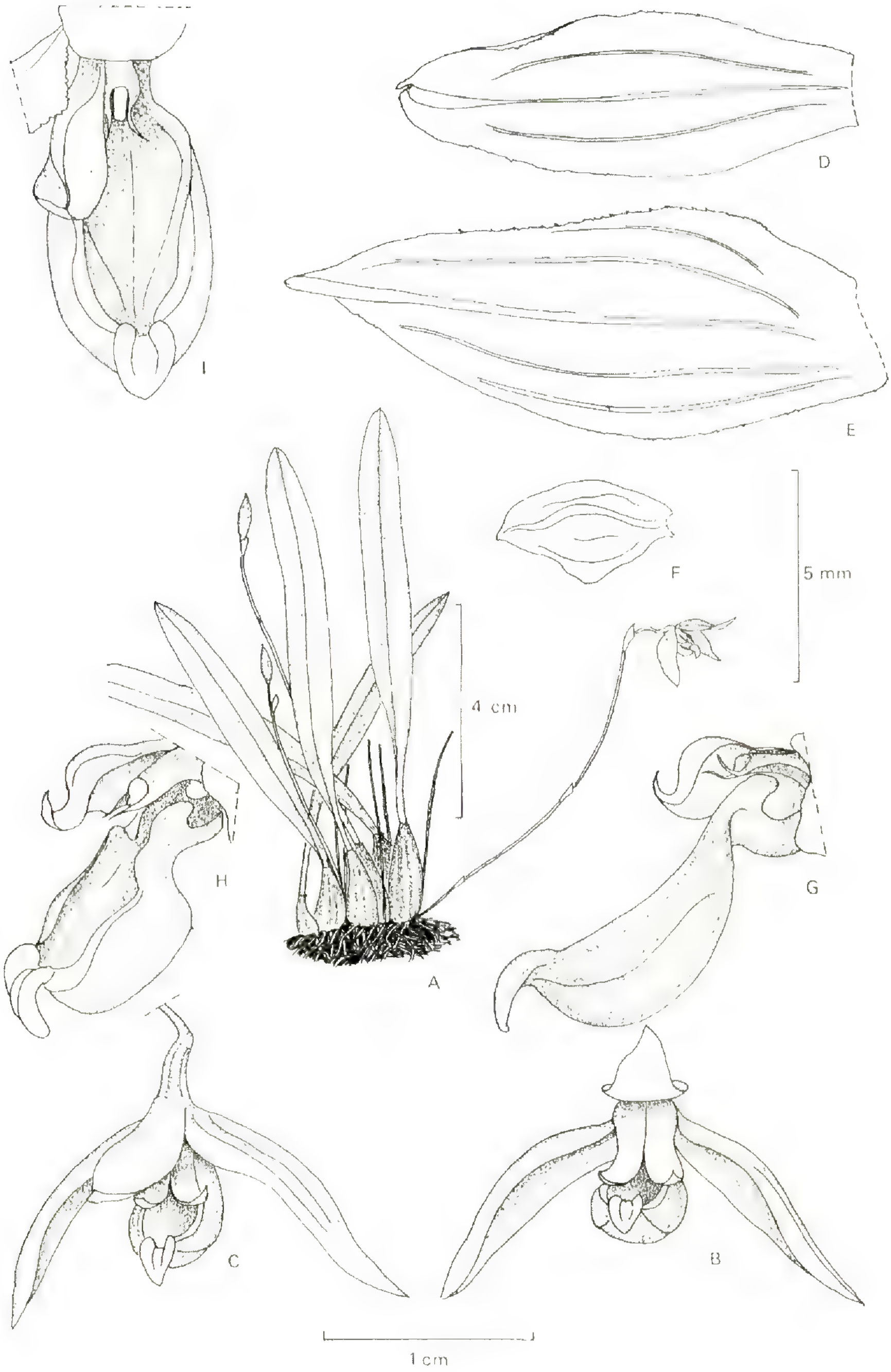


FIG. 8. *Pedilochilus longipes* Schltr. **A.** Habit, whole plants. **B.**–**C.** Flower, aspect. **D.** Dorsal sepal. **E.** Lateral sepal. **F.** Petal. **G.** Labellum with column and one petal, side view. **H.** ditto, oblique view. **I.** ditto, from above. Scale bars: A, 4 cm; B–C, 1 cm; D–I, 5 mm. Drawn from *W. Takeuchi & J. Wiakabu 9380* by N.H.S. Howcroft.

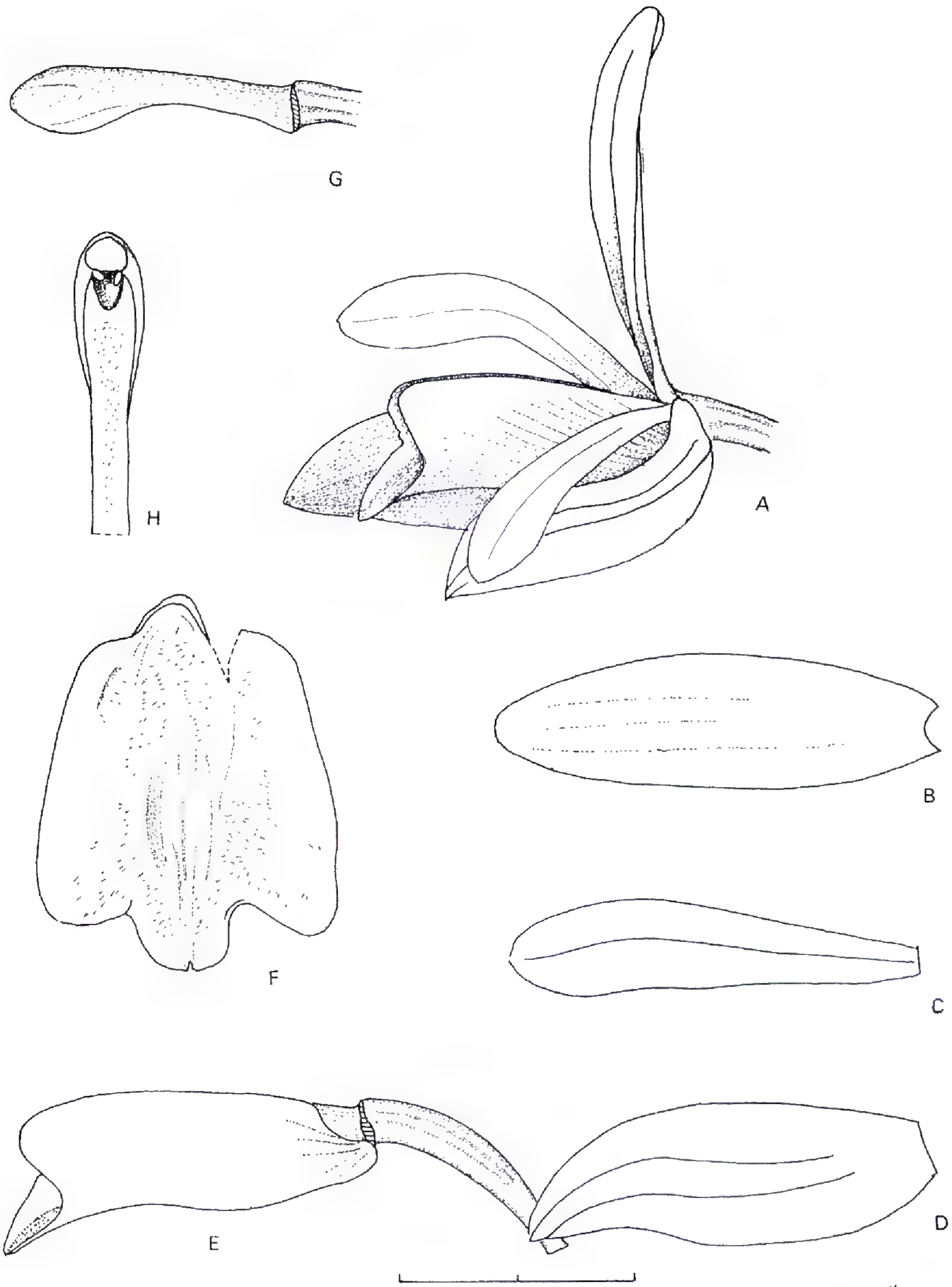


FIG. 9. *Phaius amboinensis* Bl. **A.** Flower, side aspect. **B.** Dorsal sepal. **C.** Petal. **D.** Lateral sepal. **E.** Labellum, side view. **F.** Labellum, flattened, view from above. **G.** Column, from side. **H.** Column, from below. Scale bars: A–H, 2 cm. Drawn from *W. Takeuchi & J. Wiakabu 9780* by N.H.S. Howcroft.

A widespread orchid found on many islands in the Bismarck Archipelago, but not previously recorded from New Ireland. The species distribution includes Vanuatu, Fiji, Samoa, and Tahiti in the east. Also occurring in Java, the southern Philippines (Sulu Archipelago), Sulawesi, and the Moluccas.

Phreatia loriae Schltr., Feddes Repert. Spec. Nov. Regni Veg. 3:318. 1907.

Specimen examined: **PAPUA NEW GUINEA. New Ireland Province:** junction of Niagara and Weitin rivers, expedition camp 2, lowland rainforest, 4°30.210' S, 152°56.242' E, 240 m, 21 Jan 1994 (fl, spirit), *W. Takeuchi & J. Wiakabu 9885A* (LAE).

The species was previously known only from the southern PNG mainland.

Pristiglottis montana (Schltr.) Cretz. & J.J. Sm., Acta Fauna Fl. Univ. Bucur. ser. 2, Bot. 1, 14:4. 1934. (**Fig. 10**).

Specimen examined: **PAPUA NEW GUINEA. New Ireland Province:** Hans Meyer Range, Angil Mountain, expedition camp 4, pristine subcloud forest dominated by bryophytic and ferny growth, 4°25.2' S, 152°56.8' E, 1800 m, 4 Feb 1994 (fl, spirit), *W. Takeuchi & J. Wiakabu 9394* (LAE).

The labellum of this specimen compares well with the illustration by Halle (1977). The new occurrence represents a significant disjunction from the previously known stations in Vanuatu and New Caledonia.

OTHER ILLUSTRATED COLLECTIONS

Bulbophyllum pachyglossum Schltr., Feddes Repert. Spec. Nov. Regni Veg. 16: 125. 1920. (**Fig. 11**).

Specimen examined: **PAPUA NEW GUINEA. New Ireland Province:** Hans Meyer Range, Angil Mountain, expedition camp 4, pristine subcloud forest dominated by bryophytic and ferny growth, 4°25.2' S, 152°56.8' E, 1800 m, 3 Feb 1994 (fl), *W. Takeuchi & J. Wiakabu 9375* (LAE).

Bulbophyllum pachyglossum is a member of section *Brachyostele*, within which 3 species have been described for New Guinea. Of these, only *B. pachyglossum* has been recorded from the Bismarck Archipelago. The species is also known from the Solomon Islands (Lewis & Cribb 1991).

Cadetia echinocarpa Schltr., Feddes Repert. Spec. Nov. Regni Veg. Beih. 1:439. 1912. (**Fig. 12**).

Specimen examined: **PAPUA NEW GUINEA. New Ireland Province:** junction of Niagara and Weitin rivers, expedition camp 2, lowland rainforest, 4°30.210' S, 152°56.242' E, 240 m, 21 Jan 1994 (fl), *W. Takeuchi & J. Wiakabu 9884* (LAE).

Possibly synonymous with the later name *C. homochroma* (J.J. Sm.) Schltr.

Calanthe triplicata (Willemet) Ames, Philip. J. Sci. Bot. 2:325. 1907. (**Fig. 13**).

Specimen examined: **PAPUA NEW GUINEA. New Ireland Province:** junction of Niagara and Weitin rivers, expedition camp 2, lowland rainforest, 4°30.210' S, 152°56.242' E, 240 m, Jan 1994 (fl, spirit), *W. Takeuchi & J. Wiakabu 9976* (A, K, L, LAE).

Widespread in New Guinea, the Bismarck Archipelago, and Southeast Asia.

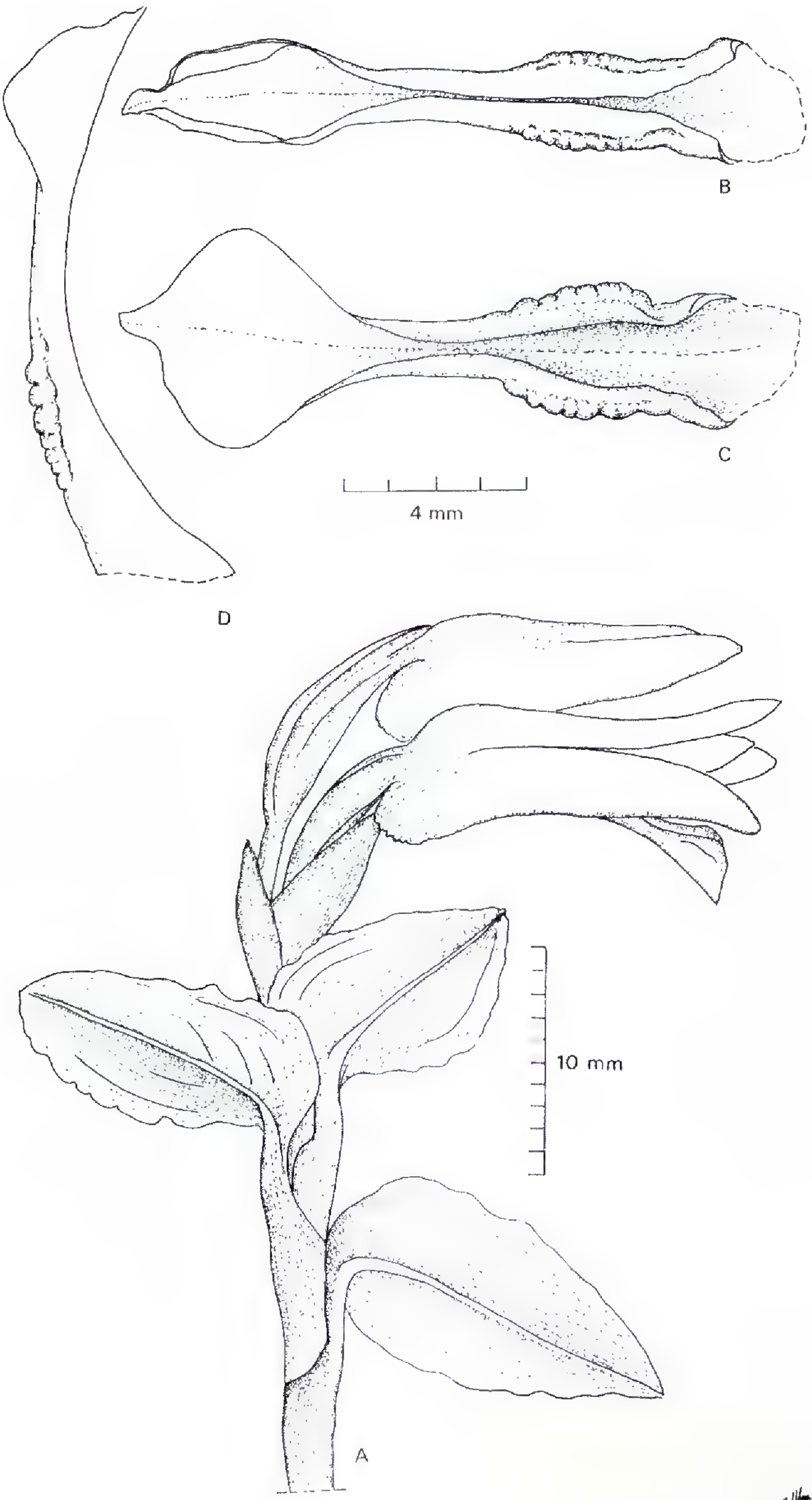


FIG. 10. *Pristiglottis montana* (Schltr.) Cretz. & J.J. Sm. **A.** Flowering habit. **B.** Labellum from above. **C.** ditto, with parts flattened. **D.** Labellum, from side. Scale bars: A, 10 mm; B–D, 4 mm. Drawn from *W. Takeuchi & J. Wiakabu 9394* by N.H.S. Howcroft.



FIG. 11. *Bulbophyllum pachyglossum* Schltr. **A.** Flowering habit. **B.** Flower, from side. **C.** Dorsal sepal. **D–E.** Petals. **F.** Lateral sepal. **G.** Labellum and column, side view. **H.** Labellum, side view. **I.** Labellum frontal view (material distorted). Scale bars: A, 5 cm; B–G, 10 mm; H–I, ×12. Drawn from *W. Takeuchi & J. Wiakabu 9375* by N.H.S. Howcroft.

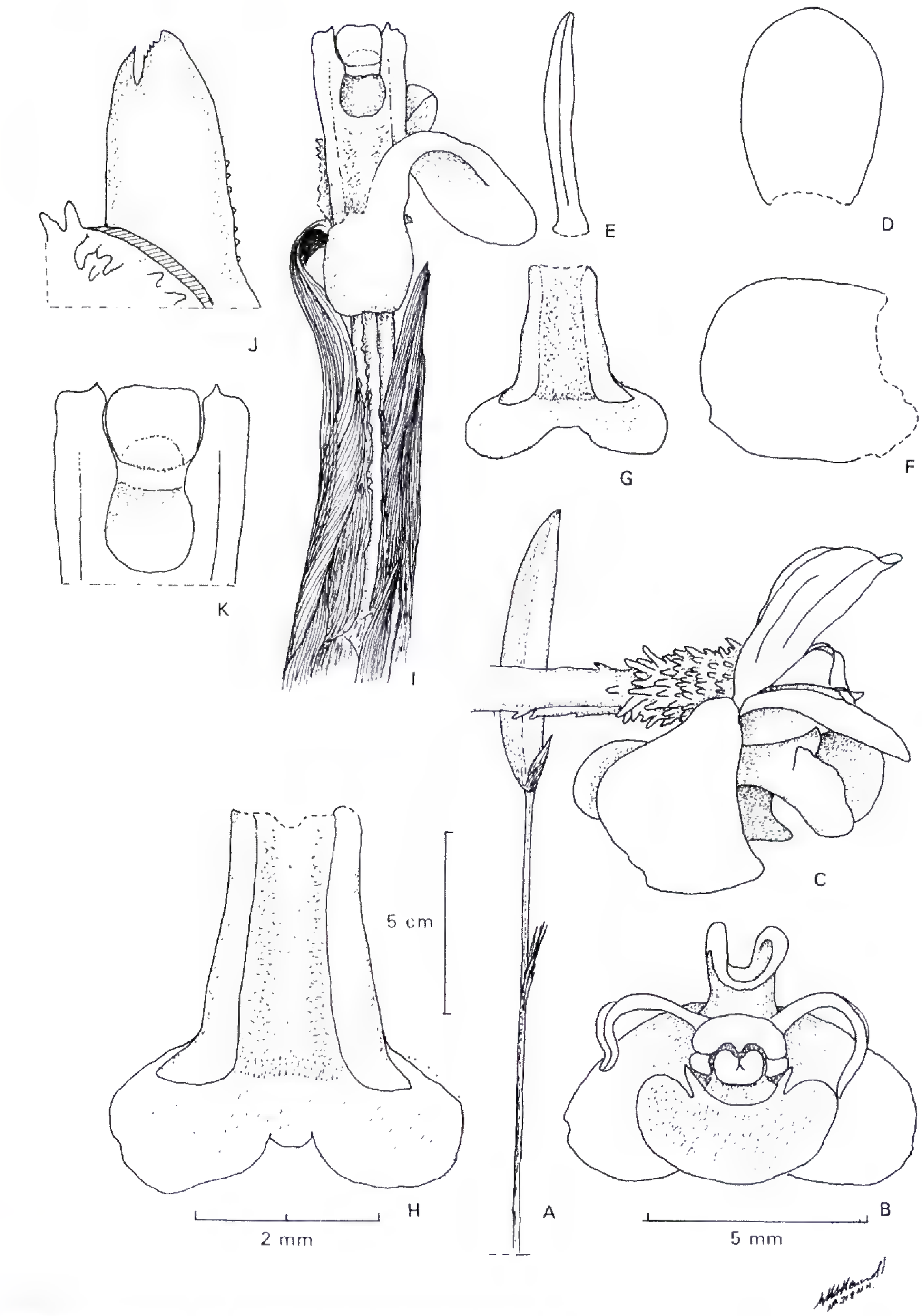


FIG. 12. *Cadetia echinocarpa* Schltr. **A.** Stem and leaf. **B.** Flower, frontal view. **C.** Flower and ovary, side view. **D.** Dorsal sepal. **E.** Petal. **F.** Lateral sepal. **G.** Labellum, from above. **H.** ditto. **I.** Partly dissected flower, showing anther, column, stigma, spur, and sheaths. **J.** Column, side view, without anther. **K.** Column apex from below, showing anther and stigma. Scale bars: A, 5 cm; B–G, 5 mm; H, 2 mm; I, 5 mm; J–K, 2 mm. Drawn from *W. Takeuchi & J. Wiakabu 9884* by N.H.S. Howcroft.

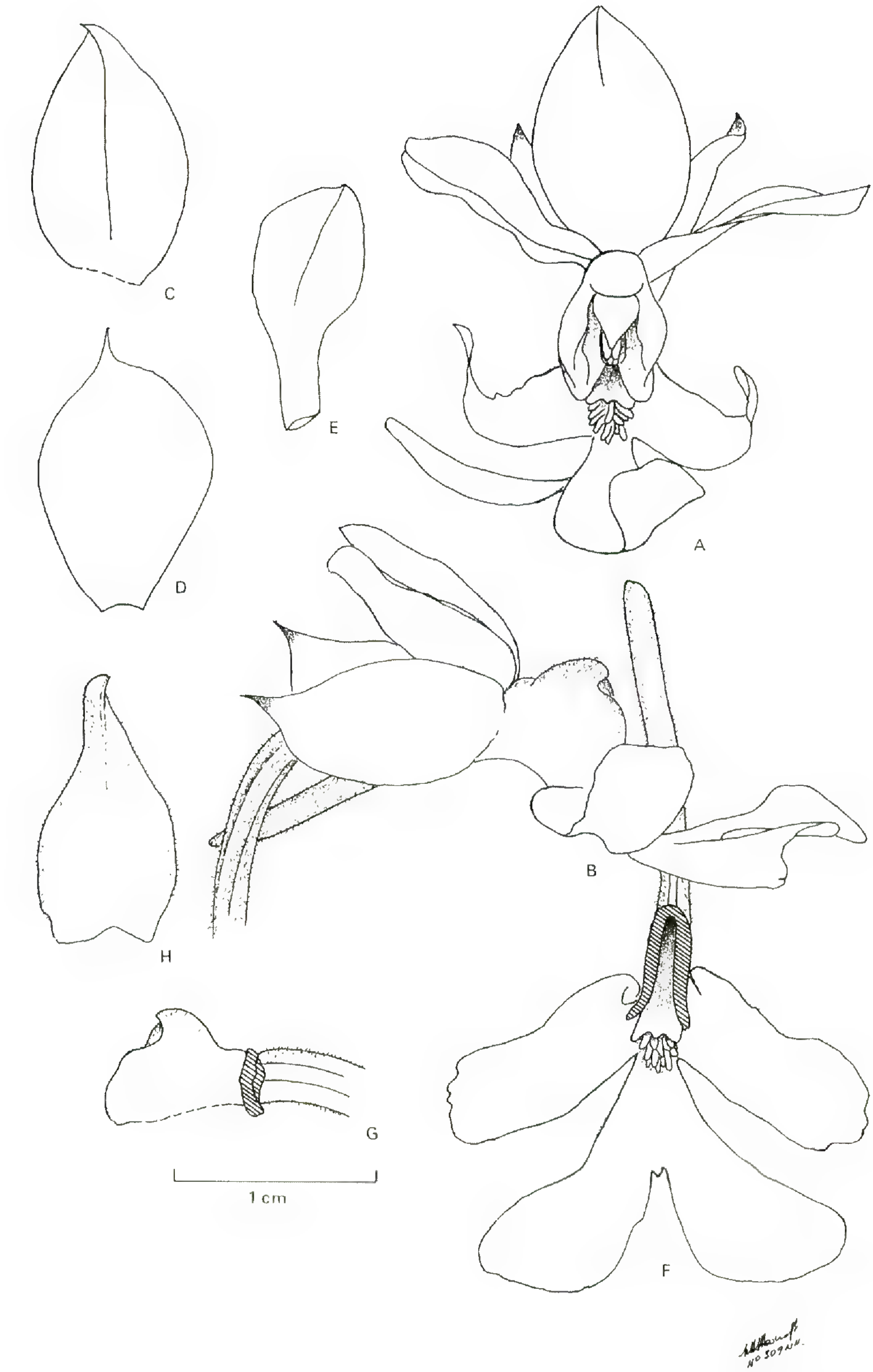


FIG. 13. *Calanthe triplicata* (Willemet) Ames. **A.** Flower, frontal view. **B.** Flower, side view. **C.** Dorsal sepal. **D.** Lateral sepal. **E.** Petal. **F.** Labellum with spur, from above. **G.** Column, side view. **H.** Floral bract. Scale bars: A–H, 1 cm. Drawn from *W. Takeuchi & J. Wiakabu 9976* by N.H.S. Howcroft.

Dendrobium cuthbertsonii F. Muell., Trans. Roy. Soc. Victoria 24:175. 1888. (**Fig. 14**).

Specimens examined: **PAPUA NEW GUINEA. New Ireland Province:** Hans Meyer Range, Angil Mountain, expedition camp 4, pristine subcloud forest dominated by bryophytic and ferny growth, 4°25.2' S, 152°56.8' E, 1800 m, 3 Feb 1994 (fl, spirit), *W. Takeuchi & J. Wiakabu 9341* (LAE); ibid., 4 Feb 1994 (fl), *W. Takeuchi & J. Wiakabu 9400* (LAE); ibid., 6 Feb 1994 (fl, spirit), *W. Takeuchi & J. Wiakabu 9452* (A, LAE).

The surface of the leaves is not verrucose, as in most mainland provenances.

Dendrobium masarangense Schltr. ssp. **masarangense**, Repert. Spec. Nov. Regni Veg. 10:78. 1911. (**Fig. 15**).

Specimen examined: **PAPUA NEW GUINEA. New Ireland Province:** Hans Meyer Range, ridge adjacent to the Weitin River, expedition camp 3, mossy montane forest, 4°27.205' S, 152°56.489' E, 1175 m, 26 Jan 1994 (fl, spirit), *W. Takeuchi & J. Wiakabu 9534* (LAE).

The white-flowered ssp. *masarangense*, with a light yellow-tipped labellum, is widespread and common on high islands. Lewis and Cribb (1991: 188) list its distribution as Sulawesi to New Guinea, New Britain, Bougainville, Guadalcanal, Vanuatu, Fiji, and New Caledonia. The senior author has examined this subspecies *in situ* from the Lelet plateau of New Ireland. However much of the habitat there has been recently destroyed by agricultural development and the orchid has now disappeared from that locality.

Dendrobium rhodostictum F. Muell. & Kraenzl., Oest. Bot. Zeit. 44:300. 1894. (**Fig. 16**).

Specimens examined: **PAPUA NEW GUINEA. New Ireland Province:** Hans Meyer Range, ridge adjacent to the Weitin River, expedition camp 3, mossy montane forest, 4°27.205' S, 152°56.489' E, 1175 m, 25 Jan 1994 (fl, spirit), *W. Takeuchi & J. Wiakabu 9514* (LAE); junction of Niagara and Weitin rivers, expedition camp 2, lowland rainforest, 4°30.210' S, 152°56.242' E, 240 m, Jan 1994 (fl), *W. Takeuchi & J. Wiakabu 9974* (LAE).

Previously recorded from New Ireland. The pseudobulbs of these specimens are less clavate than other collections from New Britain, Bougainville, and the mainland, but the perianth segments and callus agree perfectly in shape and size to the species.

Goodyera rubicunda (Bl.) Lindl., Bot. Reg. 25: 61, misc. 92. 1839. (**Fig. 17**). *Neottia rubicunda* Bl., Bijdr. 408. 1825.

Specimen examined: **PAPUA NEW GUINEA. New Ireland Province:** junction of Niagara and Weitin rivers, expedition camp 2, lowland rainforest, 4°30.210' S, 152°56.242' E, 240–300 m, 13 Feb 1994 (fl, spirit), *W. Takeuchi & J. Wiakabu 9808* (A, K, L, LAE).

In the broad sense, *Goodyera rubicunda* is distributed throughout Malesia, from peninsular Malaysia to Samoa.

Spathoglottis plicata Bl., Bijdr. Fl. Ned. Ind. 5: 401. 1825. (**Fig. 18**).

Specimen examined: **PAPUA NEW GUINEA. New Ireland Province:** junction of Niagara and Weitin

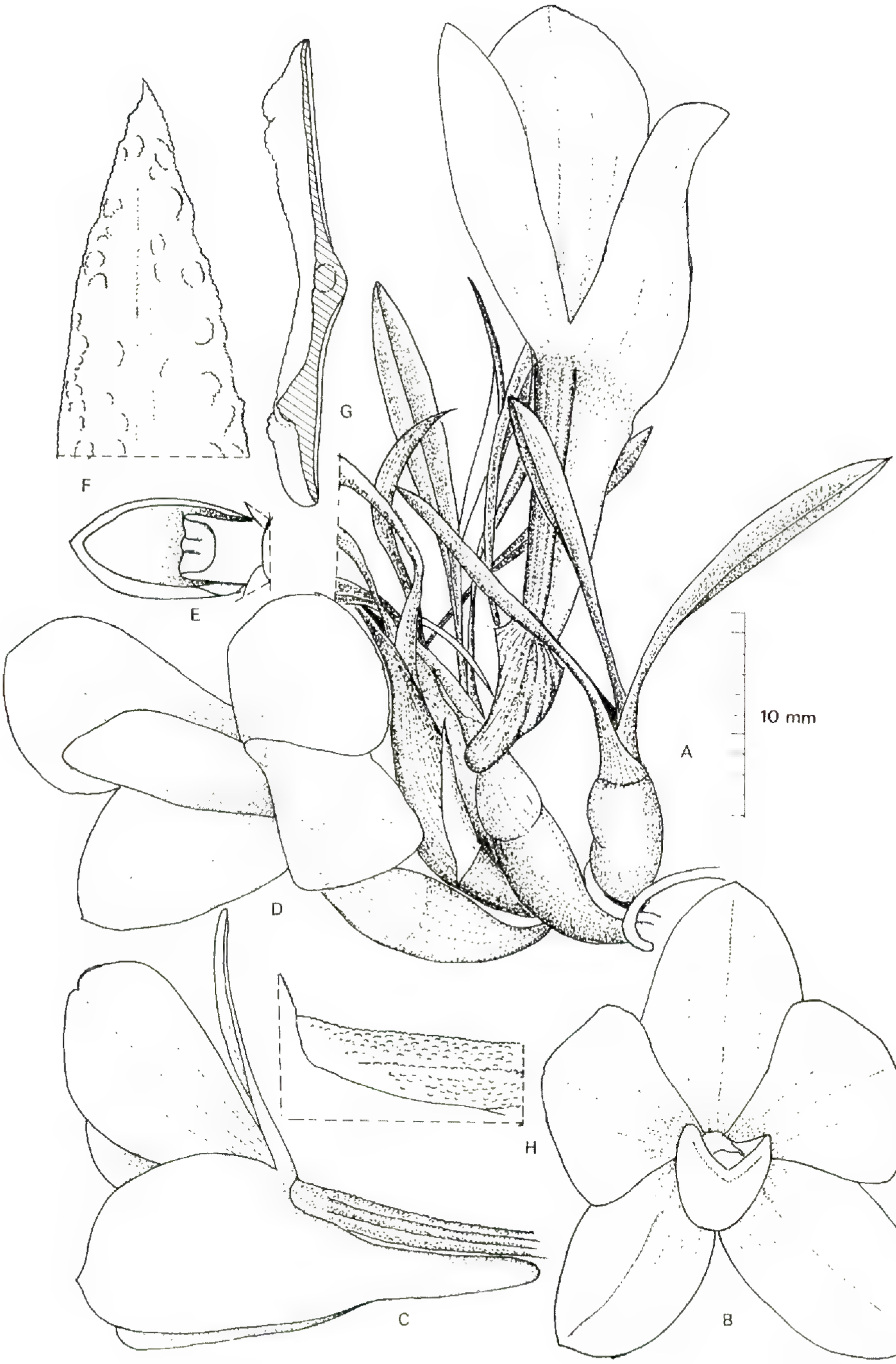


FIG. 14. *Dendrobium cuthbertsonii* F. Muell. **A.** Flowering habit. **B.** Flower, frontal view. **C.** Flower and spur, side view. **D.** Flower and labellum, side view. **E.** Labellum and column, from above. **F.** Enlarged view of leaf tip showing surface sculpting. **G.** Leaf in cross-section. **H.** Enlarged view of ovary surface. Scale bars: A–E, 10 mm. Drawn from *W. Takeuchi & J. Wiakabu 9452* by N.H.S. Howcroft.

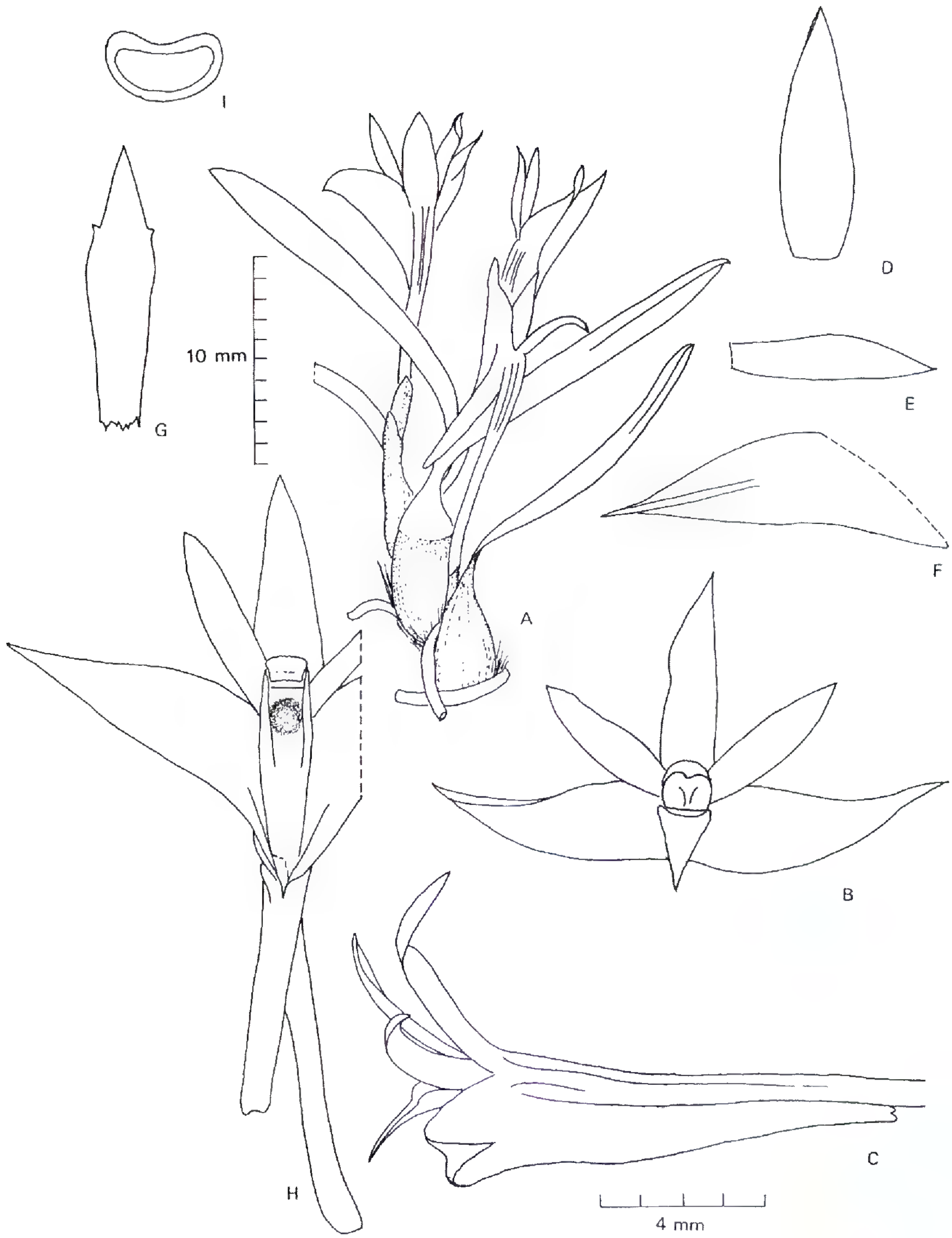


FIG. 15. *Dendrobium masarangense* Schltr. ssp. *masarangense*. **A.** Flowering habit. **B.** Flower, frontal view. **C.** Flower and spur, side view. **D.** Dorsal sepal. **E.** Petal. **F.** Lateral sepal. **G.** Labellum (basal part omitted). **H.** Flower with labellum removed, showing column, anther, stigma, and spur. **I.** Leaf cross-section. Scale bars: A, 10 mm; B–I, 4 mm. Drawn from *W. Takeuchi & J. Wiakabu 9534* by N.H.S. Howcroft.

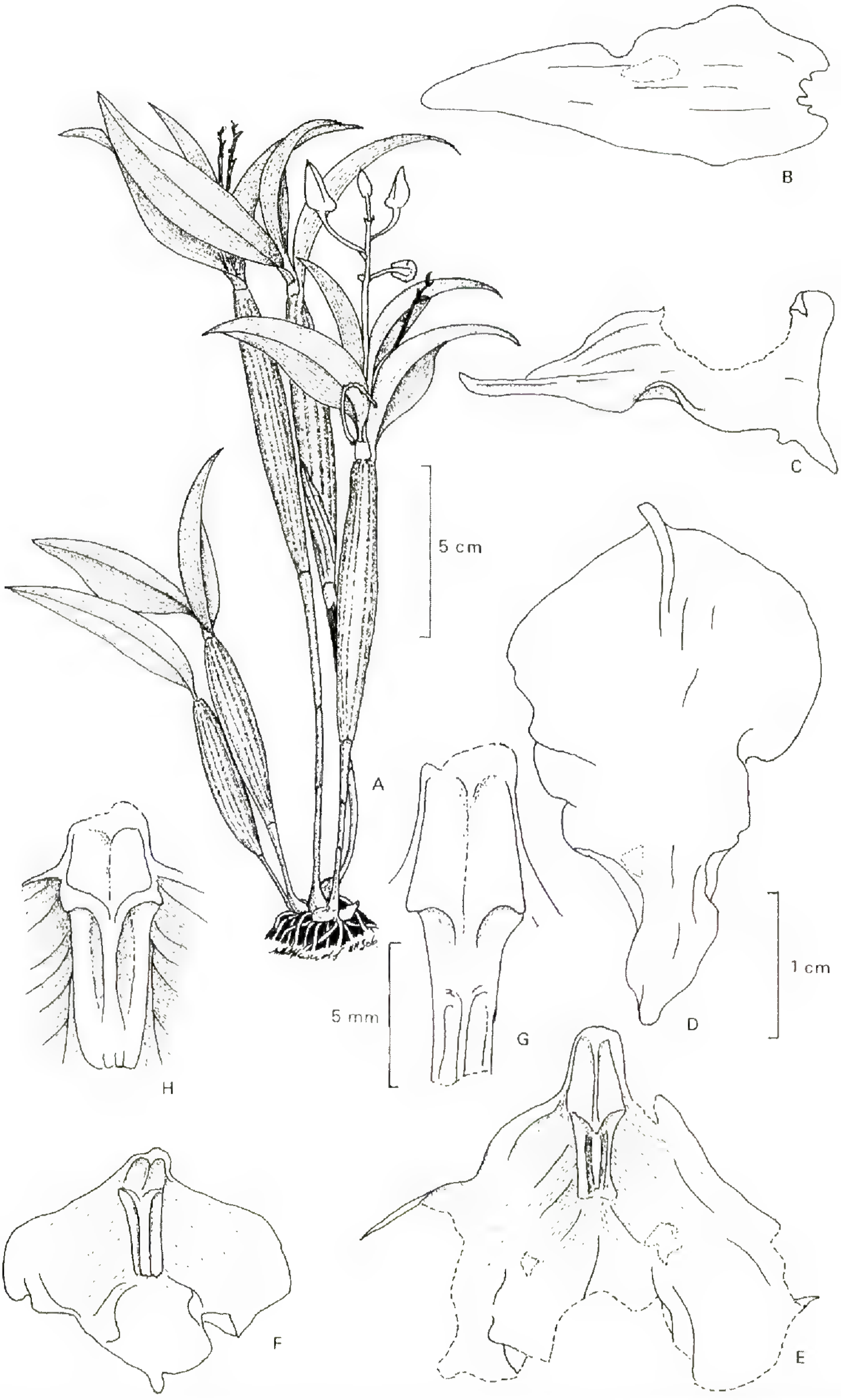


FIG. 16. *Dendrobium rhodostictum* F. Muell. & Kraenzl. **A.** Flowering habit. **B.** Dorsal sepal. **C.** Lateral sepal. **D.** Petal. **E.** Labellum (damaged). **F.** Labellum from unopened flower. **G.** Callus from mature labellum (in subdiagram E). **H.** Callus from immature labellum (in subdiagram F). Scale bars: A, 5 cm; B–F, 1 cm; G–H, 5 mm. Drawn from *W. Takeuchi & J. Wiakabu 9514* by N.H.S. Howcroft.

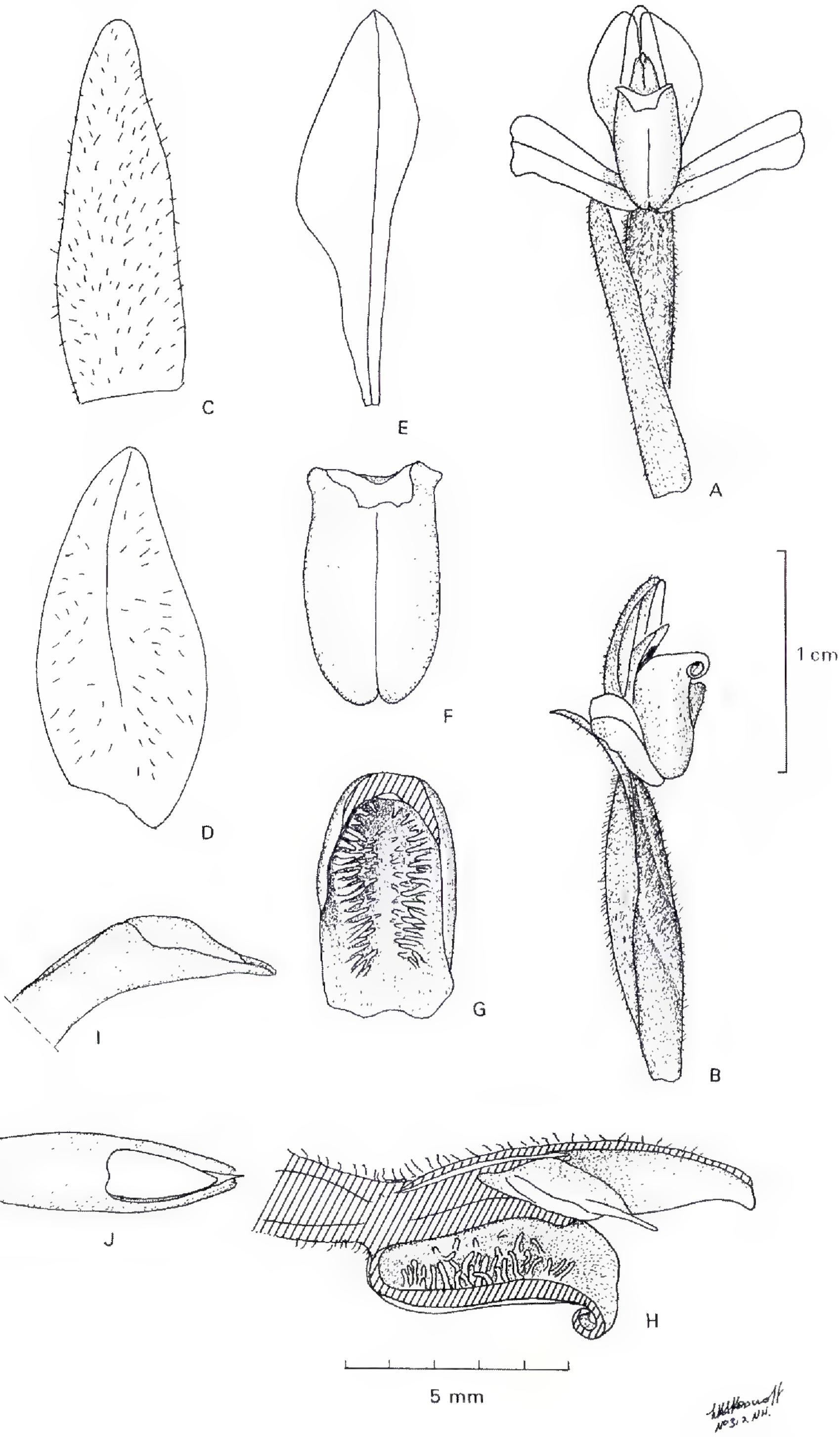


FIG. 17. *Goodyera rubicunda* (Bl.) Lindl. **A.** Flower, frontal view. **B.** Flower, side view. **C.** Dorsal sepal. **D.** Lateral sepal. **E.** Petal. **F.** Labellum, frontal view. **G.** Labellum, from above. **H.** Column and labellum in cross-section. **I.** Column. **J.** Anther. Scale bars: A–B, 1 cm; C–J, 5 mm. Drawn from *W. Takeuchi & J. Wiakabu 9808* by N.H.S. Howcroft.

rivers, expedition camp 2, lowland rainforest, 4°30.210' S, 152°56.242' E, 240 m, Jan 1994 (fl, fr, spirit), *W. Takeuchi & J. Wiakabu 9972* (LAE).

The New Ireland specimen undoubtedly belongs to the *S. plicata* complex. However the ligulate lateral lobes on the labellum, with virtually no dilation of the apices, indicate that this is not subspecies *plicata*. The lack of a distinctly arched column is suggestive of cleistogamy.

Spathoglottis taxa are distinguished primarily by the labellum, especially by the shape and angle of the lateral lobes, shape/size of the callus and its vestiture, and by claw length and width. Plant habit and morphology is of value in defining sections and subspecies (Howcroft 1986). Research by the senior author indicates that six subspecies of *S. plicata* are present in the New Guinea region, of which four have been recorded from the Bismarck Archipelago. A formal revision of Malesian *Spathoglottis* will appear in a future publication by the first author.

ACKNOWLEDGMENTS

Flowers of *Dendrobium antennatum* were provided by Wolfgang Bandisch, General Manager of the National Capital Botanical Gardens (NCBG), and by Judith Raka, NCBG Administration Manageress and Scientific Officer. Specimens representing New Ireland provenances were received from Oscar Melepia, of Gaulim in East New Britain, and from Steven Kami of Port Moresby.

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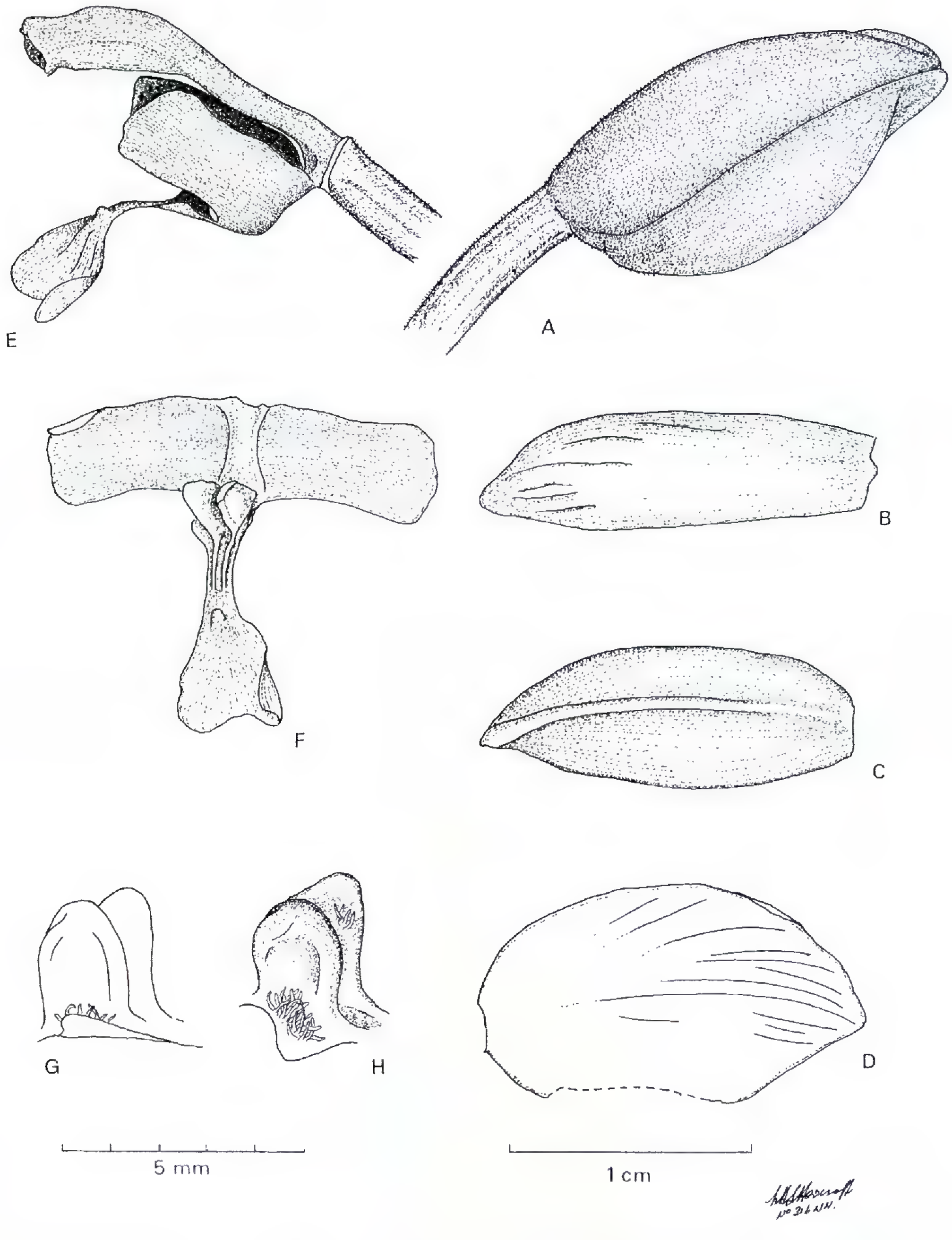


FIG. 18. *Spathoglottis plicata* Bl. **A.** Mature bud. **B.** Dorsal sepal. **C.** Lateral sepal. **D.** Petal. **E.** Column with labellum, side view. **F.** Labellum, from above. **G–H.** Bilobed callus. Scale bars: A–F, 1 cm; G–H, 5 mm. Drawn from *W. Takeuchi & J. Wiakabu 9972* by N.H.S. Howcroft.

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UNA ESPECIE NUEVA DE *PORTULACA* (PORTULACACEAE) DEL NORTE DE MICHOACÁN (MÉXICO)[1]

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RESUMEN

Se describe y se propone a *Portulaca rzedowskiana* como especie nueva para la ciencia. De acuerdo con el material examinado, este taxon se encuentra distribuido en sitios con pastizal y matorral subtropical perturbado de la parte norte del estado de Michoacán. Se caracteriza principalmente por ser de hábito perenne con raíz suberosa, por poseer hojas aplanadas a subrollizas, lanceoladas, en ocasiones oblongo-lanceoladas a oblanceoladas y por el opérculo de la cápsula que es de forma campanulada.

PALABRAS CLAVE: *Portulaca*, Portulacaceae, Michoacán, México.

ABSTRACT

Portulaca rzedowskiana is described and proposed as a new species. According to examined material this taxon is found in grasslands and disturbed subtropical scrub in the north part of the Mexican state of Michoacan. It is distinguised mainly by its perennial habit with suberous root, by its flat to subterete lanceolate leaves, sometimes oblong-lanceolate to oblanceolate in shape, as well as by the campanulated operculum of the capsule.

KEY WORDS: *Portulaca*, Portulacaceae, Michoacan, Mexico.

Durante la preparación del fascículo correspondiente a la familia Portulacaceae para la Flora del Bajío y de regiones adyacentes, se encontraron algunos ejemplares de herbario del género *Portulaca*, los cuales fueron colectados en la parte norte del estado de Michoacán (México) y que corresponden a una entidad que se puede ubicar en la subsección *Conocarpae* D. Legrand (subgénero *Portulaca*, sección *Catoclasis* D. Legrand), cuyo único miembro reportado para México es *P. mexicana* P. Wilson. Éstos ejemplares presentan características que no corresponden a ninguna de las especies conocidas en la actualidad, por lo que se propone como:

Portulaca rzedowskiana G. Ocampo, sp. nov. (**Fig. 1**). TIPO: MÉXICO. MICHOACÁN. Municipio de Morelia: Monte Rubio, pastizal, terreno plano, orilla de camino, por la vía del tren, alt. 1900 m, 1 Ago 1991, *J.M. Escobedo 2035* (HOLOTIPO: IEB; ISOTIPOS: por distribuirse).

Herba perennis crassiuscula; radix incrassata, suberosa, 2–6 cm longa, 0.5–3.5 cm lata; caules usque ad 26 cm longi, prostrati vel decumbentes; folia alterna, plana vel subteretia, lanceolata, aliquando

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oblongo-lanceolata vel oblanceolata, 4–20 mm longa, 1–3(–4.5) mm lata, apice acuta; sepala ovata, rubra, (3–)4.5–6.5 mm longa, 4–5.5(–6.5) mm lata; petala rosea vel purpurea, obovata, (5.5–)6.5–11 mm longa, (3–)3.5–6(–7) mm lata; stamina 22–44; stylus 4.5–6(–8) mm longus, lobis stigmatosis (3–)4–5(–6); capsula 3.5–6 mm longa, operculum campanulatum; semina coracina, 0.6–0.7(–0.8) mm longa, tuberculata, tuberculis basi stellulatis ornata.

Planta herbácea perenne, carnosa. Raíz engrosada, suberosa, de 2–6 cm de largo por 0.5–3.5 cm de ancho, en raras ocasiones surgen de ella raíces cilindráceas de hasta 15 cm de largo por 2–4 mm de ancho. Tallos varios surgiendo de la raíz, de 4–26 cm de largo, postrados a decumbentes. Hojas alternas, aplanadas a subrollizas, carnosas, pelos axilares de 3–5 mm de largo, pecíolo de 1–1.5(–2) mm de largo, lanceoladas, en ocasiones oblongo-lanceoladas a oblanceoladas, de 4–20 mm de largo por 1–3(–4.5) mm de ancho, ápice agudo. Flores terminales, sésiles, agregadas en cabezuelas de (2–)3–8 flores, rodeadas por un verticilo de (6–)8–10(–13) hojas, pelos de hasta 5 mm de largo; sépalos connados en su base, rojizos, ovados, de (3–)4.5–6.5 mm de largo por 4–5.5(–6.5) mm de ancho, desiguales, ápice agudo, margen escarioso, persistentes hasta la madurez de la cápsula; pétalos de color rosa a morado, connados en su base, obovados, de (5.5–)6.5–11 mm de largo por (3–)3.5–6(–7) mm de ancho, obtusos a emarginados, la mayoría de las veces con un pequeño mucrón; estambres 22–44, sus filamentos de (2.5–)3–4(–5) mm de largo, connados en su base formando un anillo estaminal de ±1 mm de largo, anteras de 0.6–0.8(–0.9) mm de largo; estilo de 4.5–6(–8) mm de largo, ramas estigmáticas (3–)4–5(–6), de 1.5–2.5(–3) mm de largo. Cápsula sésil o sobre un pedicelo de hasta 1.5 mm de largo, la cápsula de 3.5–6 mm de largo por 3–4.5(–5) mm de diámetro, con dehiscencia en su tercio inferior o más cercana a la base, opérculo campanulado a semi-campanulado; semillas de color negro-azulado cuando maduras, brillantes, reniformes, de 0.6–0.7(–0.8) mm de largo, tubérculos redondeados con estélulas radiales en su base.

Material adicional examinado: **México. Michoacán. Municipio de Acuitzio del Canje:** Las Peñas, 1 Jul 1986, *H. Díaz 2372* (CHAPA, IEB). **Municipio de Charo:** brecha rumbo a Las Mesas, 22 Jul 1987, *J. Santos 2114* (IEB); ±1.5 km sobre el camino a Las Mesas, a un costado de la cortina del bordo, 22 Ago 2001, *G. Ocampo 1128* (IEB), *1129* (IEB). **Municipio de Erongaricuaro:** Oponguio, 5 Jul 1990, *H Díaz 6205* (CHAPA, EBUM, IEB, MEXU). **Municipio de Morelia:** Puerto de Los Copales, ±8 km de Morelia sobre la carretera a Mil Cumbres, 22 Ago 2001, *G. Ocampo 1124* (IEB); alrededores de San José de las Torres, 14 Sep 1991, *E. García y E. Pérez 3930* (IEB); San José Coapa, 4 Oct 1989, *J.M. Escobedo 1845* (IEB). **Municipio de Purépero:** ±3 km de Villa Mendoza, camino a San Antonio Carupo, 2 Sep 1999, *E. Carranza et al. 5777* (IEB). **Municipio de Puruándiro:** 9 km al SE de Puruándiro, carretera a Cuitzeo, 22 Jun 1985, *H. Díaz 1162* (IEB). **Municipio de Tlazazalca:** 2 km al W de La Yerbabuena, 6 Jul 1990, *E. Pérez y E. García 1367* (IEB); bordo en la desviación a La Yerbabuena, sobre la carretera a Churintzio, 7 Jul 2001, *G. Ocampo y A. Medellín 1053* (IEB).

Portulaca rzedowskiana se ha encontrado en lugares con matorral subtropical perturbado o con pastizal, en terrenos planos o con poca inclinación, entre los 1800 y 2200 m de altitud (5920–7230 ft). Su abundancia local oscila entre escasa

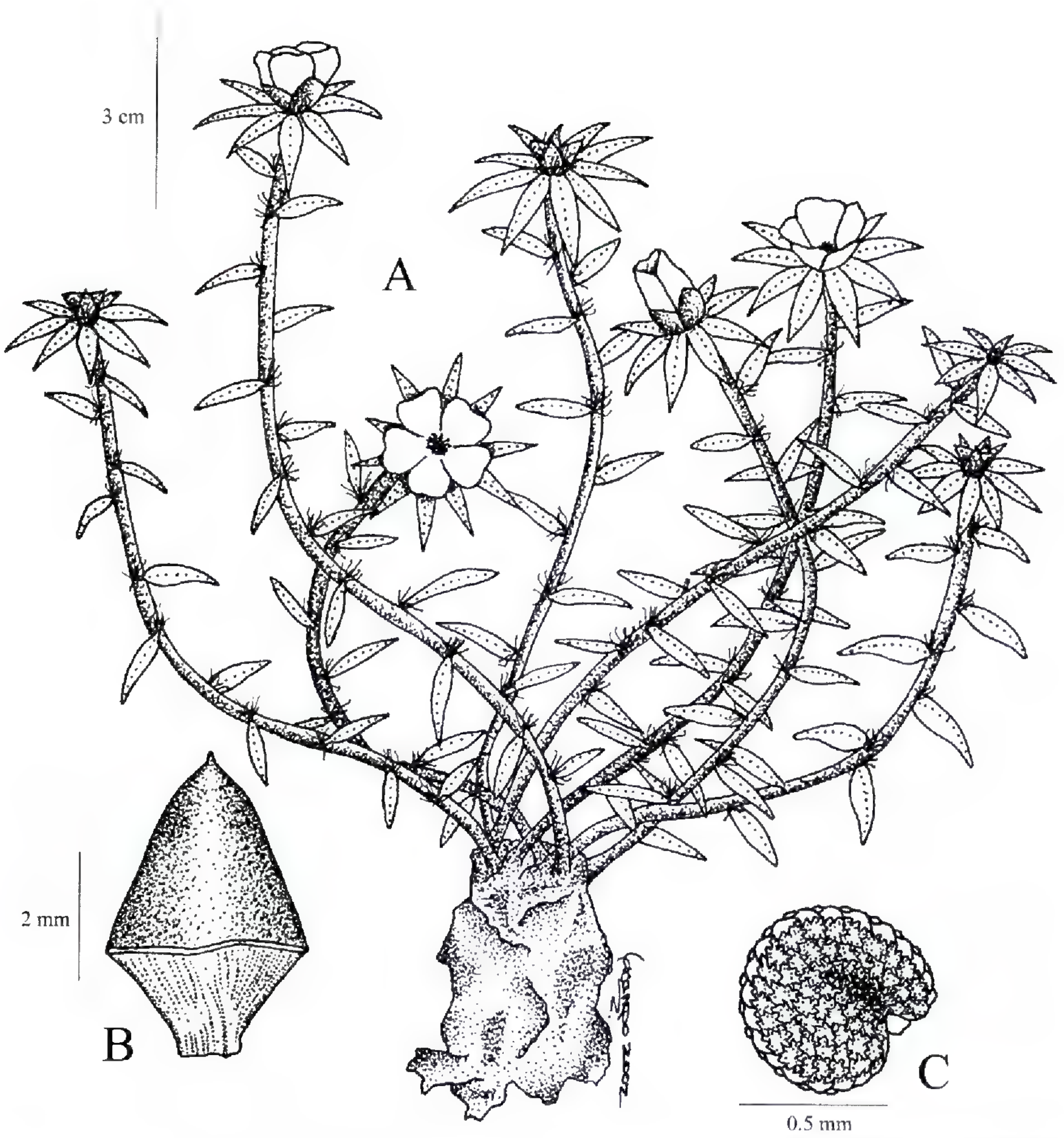


FIG. 1. *Portulaca rzedowskiana*. A. Aspecto general de la planta. B. Cápsula. C. Semilla.

y francamente abundante, por lo que se puede considerar que carece de problemas de supervivencia. Por el momento, únicamente se conoce de la parte norte de Michoacán, pero es de esperarse que esta especie se encuentre en zonas colindantes de los estados de Jalisco y Guanajuato.

Las especies de la subsección *Conocarpae* D. Legrand, muestran cápsulas con dehiscencia en su tercio inferior, el opérculo es campanulado o subconoideo (raramente casi hemiesférico) y sus hojas son rollizas a aplanadas, dispuestas en grupos de 6 a 14 en las inflorescencias (Legrand 1962). *P. rzedowskiana* tiene mayor afinidad con *P. mexicana* P. Wilson, *P. minensis* D. Legrand, *P. perennis* R. E. Fr. y con *P. wedermannii* Poelln., de las cuales se diferencia por una serie de combinación de caracteres (Cuadro 1), siendo los principales el tamaño más

Cuadro 1. Comparación de *Portulaca rzedowskiana* con otras especies de la subsección *Conocarpae*.

		P. rzedowskiana	P. mexicana	P. minensis	P. perennis	P. werdermannii
	Raíz	Engrosada, suberosa	Engrosada, no suberosa	¿?	Pivotante, suberosa	Suberosa
	Tallo	4–26 cm de largo	10 cm de largo	2 6 cm de largo	2–9 cm de largo	13 cm de argo
	Densidad de pelos axilares	Regularmente abundantes	Regularmente abundantes	Muy abundantes	Regularmente abundantes	Muy abundantes
Hojas	Forma	Aplanadas a subrollizas, lanceo adas, algunas veces oblongo-lanceoladas a oblanceoladas	Rollizas, lineales a sublineales	Aplanadas, oblongo-elípticas u oblongo-lanceoladas	Rollizas,' oblongas a suplineales	Aplanadas, oblonga a ovado-oblonga
	Tamaño	4–20 mm de largo por 1–3(–4.5) mm de ancho	4–10 mm de largo por 1.5–2 mm de ancho	6–12 mm de largo por 2–3 mm de ancho	3–8 mm de largo por 1–2 mm de ancho	10 mm de largo por 3 mm de ancho
Sépalos		(3–)4.5–6.5 mm de largo por 4–5.5(–6.5) mm de ancho	4.5–5 mm de largo por 1.5–2 mm de ancho	7.5 -8 mm de largo por 6 mm de ancho	4–6 mm de largo por 4–6 mm de ancho	10.5 mm de largo por 8 9 mm de ancho
Pétalos	Color	Rosa a morado	Amarillo	¿?	Purpúreo, rojo anaranjado o amarillo	Morado
Pétalos	Tamaño	(5.5–)6.5–11 mm de largo	4.5–6 mm de largo	¿?	4–9 mm de largo	15 mm de largo

		P. rzedowskiana	P. mexicana	P. minensis	P. perennis	P. werdermannii
No. de estambres		22–44	14–21	± 25	8–32	>100
Estilo	Tamaño	4.5–6(–8) mm de largo	1.5–3 mm de largo	3–3.5 mm de largo	2–4 mm	De hasta 6.5 mm de largo
	No. de ramas del estilo	(3–)4–5(–6)	4–5	5–6	4–7	7
Cápsula	Tamaño	3.5–6 mm de largo	3–4.5 mm de largo	3–4 mm de largo	(2–)3–4.5 mm de largo	3–4 mm de largo
	Forma del Opérculo	Campanulado	Campanulado	Campanulado a subtubuloso	Campanulado a hemiesférico	Hemiesférico
	Color	Negro-azulado	Negro	Negro	Negro a negro-rojizo	Gris
Semillas	Tamaño	0.6–0.7(–0.8) mm de largo	0.5 mm de largo	0.8–0.9 mm de largo	0.5–0.6 mm de largo	0.7 mm de largo
	Relieve	Estelulado	Diminutamente tuberculado	Tubérculos subestelulados en su base	Granulado, subrugoso a diminutamente tuberculado	Diminutamente tuberculado
Distribución		Parte N del estado de Michoacán	Desde el centro de México al N de Colombia	Brasil	Desde el N de Argentina y Bolivia a Perú	Brasil

grande que pueden alcanzar sus tallos, así como las mayores dimensiones de sus hojas y de sus cápsulas (*P. rzedowskiana* presenta las cápsulas más grandes de la subsección (D. Legrand, op. cit.), las cuales se conocían de hasta 5 mm de largo), así como por el color negro-azulado de sus semillas. En particular, la nueva entidad se diferencia de *P. mexicana* y *P. perennis* por sus hojas aplanadas, por sus pétalos de hasta 1.1 cm de largo, por presentar mayor número de estambres, así como por tener mayores dimensiones en el tamaño del estilo y el tamaño de la semilla; de *P. minensis* y *P. wedermannii*, especies de distribución sudamericana, se diferencia principalmente por la abundancia regular de la pilosidad axilar y por el menor número en las ramas del estilo.

Martín de Sessé y José Mariano Mociño, en su obra Flora Mexicana, registran a *Portulaca meridiana* L.f. (p. 132, 1891–1897) de las cercanías de Puruándiro (Michoacán), de donde también se ha colectado *P. rzedowskiana*. En la actualidad, se considera que *P. meridiana* L.f. es sinónimo de *P. quadrifida* L., especie distribuida en África, Asia, Oceanía y las Antillas. Por desgracia, de la excursión efectuada por los autores mencionados, no se conocen ejemplares en el herbario del Real Jardín Botánico de Madrid (MA) (McVaugh, p. 446, 2000) ni dibujos en la Colección Torner de la expedición de Sessé y Mociño (Hunt Institute for Botanical Documentation, Pittsburgh, E.U.A.) asociados con la especie aludida. Al revisar la descripción que Sessé y Mociño hacen del material observado, ésta parece coincidir con las características de *P. rzedowskiana*. La descripción de *P. meridiana* que se encuentra en la Flora Mexicana se transcribe a continuación:

Portulaca foliis lineari-subulatis, carnosis, axillis pilosis; floribus polyandris, terminalibus, sessilibus. Fl. Mex.

Portulaca foliis ellipticis, carnosis, planis, articulis pilosis, floribus sessilibus, terminalibus. Herba dodrantalis, caule tereti, glabro, succulento. Folia alterna, lineari-subulata, carnosa, sessilia, glaberrima, pilis fasciculatis, utrinque axillaribus ornata. Flores rubro-purpurei, polyandri, terminales, in capitulum sessiles, verticillum foliorum suffulti. Capsulae ovatae, circumcisae.

Habitat prope Oppidium Puruandirum. Floret Iulio.

Portulaca meridiana es una planta anual, con hojas opuestas, aplanadas, con flores rodeadas por un verticilo de 4 hojas, con pétalos amarillos y con el opérculo de la cápsula de forma campanulado-tubulosa. La disposición opuesta de las hojas, entre otras características, la ubican en el subgénero *Enantiophylla* D. Legrand, por lo que la asignación del nombre de *P. meridiana* que hicieron Sessé y Mociño a los ejemplares que observaron cerca de Puruándiro es incorrecta. La descripción en Flora Mexicana concuerda con las características de la nueva entidad, por lo que muy probablemente se trate de la misma unidad taxonómica.

Etimología.—El epíteto específico está dedicado a la Maestra Graciela

Calderón de Rzedowski y al Dr. Jerzy Rzedowski Rotter por su incansable e invaluable labor en pro del conocimiento botánico de México.

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Book Notice

Garrett E. Crow and C. Barre Hellquist. 2000. **Aquatic and Wetland Plants of Northeastern North America: A Revised and Enlarged Edition of Norman C. Fassett's A Manual of Aquatic Plants, Volume 1. Pteridophytes, Gymnosperms, and Angiosperms: Dicotyledons.** (ISBN 0-299-16330-X, hbk.). $90.00, 480 pp, 338 line illus., 1 map, 8 1/2" × 11".

Garrett E. Crow and C. Barre Hellquist. 2000. **Aquatic and Wetland Plants of Northeastern North America: A Revised and Enlarged Edition of Norman C. Fassett's A Manual of Aquatic Plants, Volume 2. Angiosperms: Monocotyledons.** (ISBN 0-299-16280-X, hbk.). $90.00, 400 pp, 268 line illus., 1 map, 8 1/2" × 11".

The University of Wisconsin Press, 1930 Monroe Street, 3rd Floor, Madison, WI 53711-2059, U.S.A. (Orders: Customer Service Department, The University of Wisconsin Press, c/o Chicago Distribution Center, 11030 S. Langley Ave., Chicago, IL 60628, U.S.A.; 773-568-1550; fax 800-621-8476, 773-660-2235).

This 2-volume set updates the original 1940 Fassett manual and its successor, the 1957 revision by Eugene Ogden—it is a guide to identification of native or naturalized vascular plants growing in "the region from Newfoundland west along the 50th parallel to southeastern Manitoba and Minnesota, south to Virginia and Missouri. Thus, on the southern edge, our range abuts the range covered by Drs. Godfrey and Wooten in their "*Aquatic and Wetland Plants of the Southeastern United States.*" Volume 1 treats "Pteridophytes, Gymnosperms, and Angiosperms: Dicotyledons"; Volume 2 treats "Angiosperms: Monocotyledons." Species of "salt marshes and tidal waters" and those "which typically occur in saturated peat" are included but "not terrestrial plants which may occur typically on flood plains, in woodland springs, or along vernal woodland or seasonal alpine brooks." The keys, which "utilize vegetative features as much as possible," "treat a total of 1139 species (1186 taxa) representing 295 genera in 109 families." "The 606 plates include figures of 1087 taxa, with 92 percent of the taxa fully or partly illustrated, [and] ... references to the figures are included in the keys." Habitat information and geographical distributions "have been drawn widely from the published literature ... and from herbarium specimens documenting locations not cited in the literature, and from our own field experience." The nicely bound, large-size, easy to-use format of the volumes, spacious plates with black-and-white line drawings, effective keys, and wide taxonomic coverage promise that this contribution will be useful in many contexts.—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX, 76102-4060, U.S.A.*

AGAVE OVATIFOLIA (AGAVACEAE), UNA NUEVA ESPECIE DE MAGUEY DEL NORESTE DE MÉXICO

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RESUMEN

Una especie de maguey, *Agave ovatifolia* Starr & Villarreal de la Sierra de Lampazos en el norte de Nuevo León es propuesta como nueva. Es ubicada en la sección *Parryanae* de subgénero *Agave* y se discute su relación con *A. havardiana* Trel. y *A.parrasana* Berger. Se presenta una ilustración de la planta y una clave parcial y modificada de la sección *Parryanae* (Gentry 1982:526).

ABSTRACT

A new species, *Agave ovatifolia* Starr & Villarreal from the Sierra de Lampazos in northern Nuevo Leon is described and illustrated. It belongs in the section *Parryanae* of the subgenus *Agave*, and its relationship to *A. havardiana* Trel. and *A. parrasana* Berger is discussed. A partial, modified key to section *Parryanae* (Gentry 1982:526) is provided.

KEY WORDS: Agavaceae, *Agave*, Flora of Mexico

La colecta de material proveniente del norte del estado de Nuevo León proporciona información de una nueva especie de *Agave*.

Agave ovatifolia Starr & Villarreal, sp. nov. (**Figs. 1 y 2**). TIPO: MÉXICO. NUEVO LEÓN: municipio de Bustamente, Sierra de Lampazos, rancho Minas Viejas, 26° 39' N, 100° 24' W, Bosque de *Quercus canbyi, Quercus laceyi, Juniperus, Crataegus, Ribes, Ungnadia, Vitis*, entre otras, 1100–1200 m, 19 Jun 2001, *J.A. Villarreal 9180, M.A. Carranza y J.A. Encina* (HOLOTIPO: MEXU, ISOTIPOS: ANSM, TEX).

Planta multiannuus, acaulis, rosula hemisphaericus, compactus, 80–120 cm diámetro, 60–90 cm alta; foliis 40–50 in 8–10 stratis, ellipticus, 35–45 cm longis, 20 24 cm latus, griseo-azureus, apice acuminatus, spina terminalis 2 cm longa, margine 15–19 paribus dentes separatus 20–25 mm; inflorescentia 3.5–4.0 m alta, ovatus-ellipticus, 13–16 rami floribus 30–50 cm longis; bracteis ellipticus-triangularis, inferiora 20–25 cm longis, 8–10 cm latis, superiora 12–15 cm longis, 7–9 cm latis; pedicelli 4–8 mm longi; flores 67–74 mm longum, flavo-virens, ovarium cylindricus, 30–35 mm longis, perianthii collo 7 mm longo, peranthii tubo 15–20 mm longo, 15 mm lato, tepala 20 mm longa, 5–7 mm lata, fila 50–60 mm longa insertus basis tepalas; capsula cylindricus, 50–60 mm longis, 15–20 mm latis; semina 5–6 mm longa, 3–4 mm lata.

Plantas multianuales; rosetas hemisféricas, algo compactas, 80–120 cm diámetro, 60–90 cm alto; hojas arregladas en 8–10 hileras, 40–50 hojas por planta, elípticas, ligeramente cóncavas a casi planas, 35–45 cm de largo, 20–24 cm de ancho en la parte media, de color glauco-grisáceo, ocasionalmente con 1–2 costillas dorsales, base ensanchada, ápice acuminado con borde de color café,

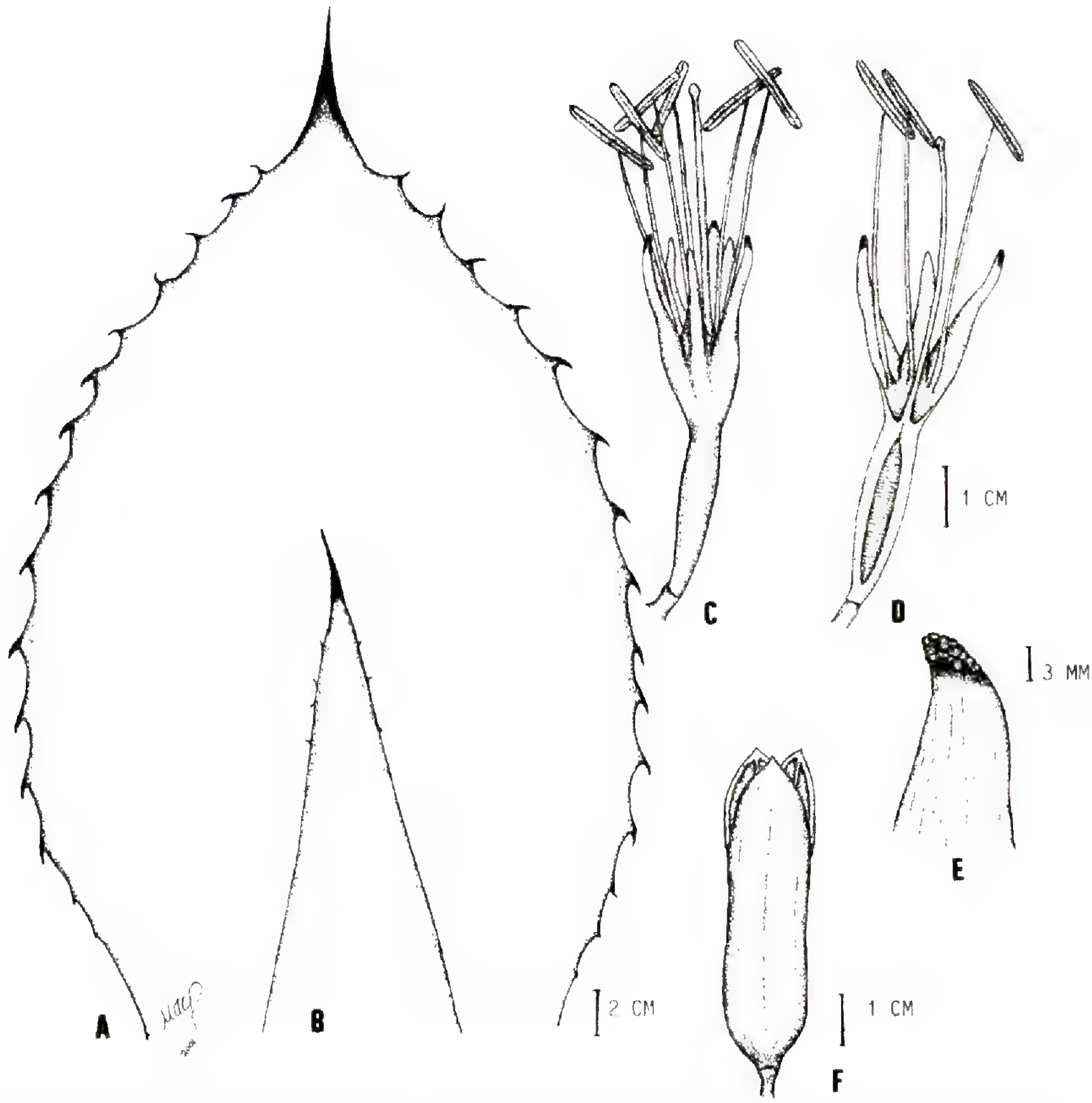


FIG. 1. *Agave ovatifolia*. **A.** hoja. **B.** bráctea. **C.** flor, corte longitudinal. **E.** glándula en el extremo del tépalo. **F.** cápsula.

espina terminal de cerca de 2 cm de largo, margen recto, con 15–19 pares de dientes ligeramente curvados, separados 20–25 mm, más próximos cerca de la base; inflorescencia 3.5–4 m alto, forma elíptica a largamente ovoide, escapo floral 9–11 cm ancho en la base, 6–8 cm en la primer ramificación, raquis algo sigmoideo, 13–16 ramillas florales, de 30–50 cm de largo, ubicadas en la mitad superior del escapo; brácteas elíptico-triangular, esparcidas, las basales 20–25 cm largo, 8–10 cm ancho en la base, las superiores 12–15 cm largo, 7–9 cm ancho en la base, acuminadas con espina terminal, enteras a dentadas, delgadas (papiráceas), glaucas, pronto se deshidratan y cambian a color café-claro, la mayoría erectas; flores en 5–6 umbelas densas, 67–74 mm largo, verde amarillentas; pedicelos 4–8 mm largo, ovario cilíndrico, 30–35 mm largo, cuello del perianto 7 mm largo, tubo del perianto 15–20 mm largo, 15 mm ancho en la parte media, tépalos largamente triangulares, 15–17 mm largo, 5–7 mm ancho



Fig. 2. Planas de *Agave ovatifolia* en su habitat y en floración.

en la base, los tres más externos con evidentes glándulas apicales, filamentos 50–60 mm largo, ligeramente aplanados insertos en la base de los tépalos, verde amarillento, anteras 22–25 mm largo, verdes, estilo 8–9 cm largo; cápsulas cilíndricas 50–60 mm largo, 15–20 mm ancho, color café oscuro; semillas lacrimiformes, 5–6 mm largo, 3–4 mm ancho, color negro brillante.

Crece en laderas y mesetas rocosas entre los 1100–1500 m, tanto en bosque de encino como matorral de *Agave lechuguilla* y arbustos espinosos. Su distribución es restringida en el área antes mencionada con la posibilidad de que se encuentre también en otras sierras aledañas. Las poblaciones son esparcidas, donde no se observan hijuelos ni la formación de colonias. La planta es reportada como buena forrajera para el ganado y las poblaciones son menguadas por jabalíes y otra fauna silvestre. Sólo se observaron plantas maduras y en floración en laderas con fuerte pendiente, donde escapan a la depredación. Localmente se le conoce como "noga" y se le diferencia de las plantas que carecen de hojas con costillas dorsales, las cuales son denominadas "maguey noga."

La especie se ubica en la sección *Parryanae* del trabajo de Gentry (1982) y al parecer esta relacionada morfológicamente con *A. havardiana* Trel. y *A. parrasana* Berger, de las cuales se diferencia por sus hojas proporcionalmente

más anchas, de color gris-azuloso y flores con tamaño intermedio, como se muestra en la siguiente clave modificada. Aunque las dimensiones de las hoja en *A. havardiana* y *A. ovatifolia* se sobreponen, la relación entre el largo y ancho es diferente, la de *A. havardiana* es de 2.0–2.8, mientras que la de *A. ovatifolia* es de 1.5–1.8. La relación entre largo y ancho de la hoja en *A. parrasana* es de 2.0–2.5, pero con hojas consistentemente más cortas. Agave *havardiana* se distribuye en el suroeste de Texas y regiones adyacentes de Chihuahua y Coahuila, *A parrasana* en sierras del centro y sur de Coahuila, mientras que *A. ovatifolia* en la Sierra de Lampazos en el norte de Nuevo León.

Agave ovatifolia es ubicado en la sección Parryanae, y la clave de Gentry (1982:526) puede ser modificada como sigue:

2. Rosettes globose, suckering copiously with long rhizomes forming large, spreading clones; panicles deep with 20 40 umbels; flowers 60–80 mm long ____ **3**
2. Rosettes not globose, more openly flat-topped, with few or no suckers; panicles rather wide and open with 10–20 large umbels; flowers 67–90 mm long ____ **7**
   7. Leaves larger, 30–70 ≤ 15 -25 cm, long acuminate; teeth reflexed along middle and lower leaf margins; tepals about equaling to slightly longer than tube. Big Bend Region and adjacent Mexico ____ **8**
   7. Leaves smaller, 20–30 ≤ 10–12 cm, the apex abruptly acute; teeth not reflexed along margins; tepals about twice as long as tube. Sierras of southern Coahuila. ____ **Agave parrasana** p. 537
      8. Leaves relatively long and narrow, 30–70 × 15–25 cm, the length 2 or more times the width, ovate-acuminate to long-acuminate, leaf tip acute, glaucous gray to light green, spine stouter, 3–5(–10) cm long; flowers 68 88 mm long, tepals 18–24 mm long; Big Bend, east-central Chihuahua and northwestern Coahuila, Mexico ____ **Agave havardiana** p. 531
      8. Leaves relatively short and broad, 35–45 ≤ 20–24 cm, the length less than 2 times the width, elliptic to ovate-el iptic, leaf tip obtuse, silver blue to grayisn sky blue, spine 2 cm long; flowers 67–74 mm long, tepals 15–17 mm long, Nuevo León, Mexico ____ **Agave ovatifolia**

Al parecer *A. ovatifolia* es la misma planta que Mrs. Anna B. Nickels colectó y distribuyó como *A. noah* Nickels a finales del siglo antepasado. La especie de Mrs. Nickels no fue descrita y tampoco fue apropiadamente publicada, a pesar que Trelease (1911) la enlista como sinónimo de *A. wislizeni* Engelm. La taxonomía de *A. wislizeni* ha sido ampliamente discutida por Gentry (1975) y Ullrich (1992). El concepto de Trelease (1911) para *A. wislizeni* acomoda bien con *A. parrasana* pero no para *A. ovatifolia*. Lynn Lowery, renombrado horticultor texano, colectó esta especie de Sierra de Lampazos, a principios de los 1990´s. El epíteto específico hace referencia a las hojas relativamente anchas en relación a su largo.

AGRADECIMIENTOS

Nuestro agradecimiento a el señor Pedro Elizalde Cantú, por permitirnos colectar material botánico en su rancho. A Ron Gass, Miguel A. Carranza y Juan

A. Encina por acompañarnos en las visitas a campo. La ilustración es obra de Miguel A. Carranza.

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Book Notice

Laurence J. Dorr, Basil Stergios, Alan R. Smith, and Nidia L. Cuello A. Chief Editor: Laurence J. Dorr. 2000. **Catalogue of the Vascular Plants of Guaracamal National Park, Portuguesa and Trujillo States, Venezuela.** (ISSN 0097-1618, pbk). Contributions form the United States National Herbarium, Volume 20:1–55. Department of Botany, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560-0166, U.S.A. Price not given, 155 pp, 3 figures, 7" × 10".

"Guaracamal National Park, which lies southwest of the city of Boconó, preserves lower montane forest, cloud forest, and paramó in the northeastern-most portion of the venezuelan Andes." It covers 21.5 km2 and ranges between 1600–3100 meters in elevation. "The specimens examined for this catalogue are mostly our own collections. These have been deposited in NY, PORT, UC, and US, and the duplicates have been distributed widely."

The catalogue treats a total of 147 families, 517 genera, and 1227 species—236 species (in 62 genera) of ferns and fern allies, 237 species (in 92 genera) of monocots, 752 species (in 361 genera) of dicots, and 2 species of pines (in 2 genera). The ten most important families in Guaracamal National Park in terms of the number of species are (in order) Orchidaceae -115, Asteraceae–102, Rubiaceae–73, Piperaceae–47, Dryopteridaceae–46, Melastomataceae–44, Solanaceae–35, Poaceae–33, Grammitidaceae–29, and Lauraceae–27. Thirty-three vascular plant taxa have been described (as new to science) from material collected in the park. A brief statement of collection localities, elevational range, exsiccatae, common names and uses, endemic and near-endemic status, and adventive and cultivated species is given for each species, where applicable. Relevant taxonomic references are provided at the end of each family treatment.—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX, 76102-4060, U.S.A.*

Journal Notice

Acta Botanica Hungarica. (ISSN 0236-6495). Akadémiai Kiadó, Budapest, H-1519 Budapest, P.O. Box 245, HUNGARY. (Subscriptions: 36-1-464-8221, email: kiss.s@akkrt.hu). $192.00, 4 issues/year, 6 1/2" × 9 1/2".

Contents for 44(1–2) 2002:**1)** Arbuscular mycorrhizal fungi (Glomales) in Egypt. II. An ecological view of some saline affected plants in the deltaic Mediterranean coastal land; **2)** Ultrastructural studies on *Vicia faba* and its pathogen *Botrytis fabae* in response to lithium chloride; **3)** Taxonomy and morphology of uncultivated hemp (*Cannabis sativa* L.) was weed in Hungary; **4)** Los géneros *Ceuthorcarpus* Aiello y *Schmidtottia* Urb (Rubiaceae); **5)** Salt tolerance variation in some common trees; **6)** A spectrum of phytoplankton flora along salinity gradient in the eastern Niger delta area of Nigeria; **7)** Top-forests (*Veratro nigri-Fraxinetum orni*) of the Bakony Mountains; **8)** The growth characteristics of *Fumana procumbens* (Dunal) Gren. et Godron under different climatic conditions; **9)** Detection of phenoloids in some Hungarian *Inula* and *Centaurea* species, **10)** Gibberellic acid effects on protein pattern, hydrolytic enzyme activities and ionic uptake during germination of *Vicia faba* in sea water; **11)** Distribution and phytosociological relations of two introduced plant species in an open sand grassland area in the Great Hungarian Plain; **12)** Cytotaxonomic studies on some *Vicia* L. species growing in the eastern Mediterranean and southern Aegean regions II.

A NEW SPECIES OF *LITHOSPERMUM* (BORAGINACEAE) FROM NUEVO LEON, MEXICO

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ABSTRACT

Lithospermum hintoniorum is newly described and illustrated. It reportedly occurs in marshy areas of oak woodlands in southern Nuevo Leon, Mexico at elevations of about 1500 meters. It is seemingly most closely related to the widespread *L. calycosum* but is distingished by a number of characters, including both vegetative and floral features.

RESUMEN

Se describe y se ilustra ***Lithospermum hintoniorum***. Se ha localizado en áreas encharcadas de robledales en el sur de Nuevo León, México en elevaciones de unos 1500 metros. Parece ser que su pariente más cercano es el muy frecuente *L. calycosum* del que se diferencia por varios caracteres, tanto vegetativos como florales.

Routine identification of Hinton collections from northeastern Mexico has revealed the following novelity:

Lithospermum hintoniorum B.L. Turner, sp. nov. (**Fig. 1**). TYPE: MEXICO. NUEVO LEON: Mpio. Aramberri, San Juan de Aviles, "Marsh in oak woods," ca. 1480 m, 13 May 1992, *Hinton et al. 21950* (HOLOTYPE: TEX; ISOTYPES: personal collections of the collectors).

Simile *Lithospermo calycosa*, lobos corollarum noncrenulatos, nuculasque majoris (ca. 3 mm altas vice 2 mm) et griseas.

Perennial herbs 12–17 cm high, the stems seemingly recumbent and arising from woody roots which exude a violet-colored dye. Leaves basal at first, but soon developing 20 or more overlapping cauline leaves, these gradually reduced upwards and grading into the floral bracts; blades linear-lanceolate to lanceolate, essentially nonvenose, except for the midribs, the surfaces appressed-strigose, the undersurfaces having finer hairs, the upper surfaces with coarser hairs having attractive flattened basal cells 0.15–0.30 mm across. Inflorescence decidedly scorpioid, having numerous bracteate pale yellow flowers. Sepals 5, linear, mostly 7–9 mm long, moderately pubescent without, glabrous within, weakly glandular at the throat, markedly nodular-annulate at or near the base; lobes 5, ovate, 1.4–1.6 mm long, 1.0–1.2 mm wide. Anthers 5, dorsifixed, ca. 1.7 mm long, inserted in the throat but not exceeding the lobes. Styles ca. 11 mm long, glabrous, minutely bifid at apex. Nutlets 2–4, glossy-gray, not at all ornamented, ca. 2 mm high, 1.5 mm wide, basally attachment ca. 2 mm across.

The relationship of this taxon among Mexican species of *Lithospermum* is



Fig. 1. *Lithospermum hintoniorum*. Freshly dug garden-grown plants from material obtained at the type locality.

moot. Assuming the plants to be consistently homostylous with weakly developed faucal appendages, it will begrudgingly key to *L. calycosum* (Macbride) I.M. Johnst. in Johnston's (1952) treatment of *Lithospermum*, to which it is compared in the above diagnosis. It differs in having much larger, broader, leaves, noncrenulate corolla lobes, and larger (ca. 3 mm high vs 2 mm), glossy-gray nutlets.

It is a pleasure to name this species for the remarkable Hinton family, who first collected the taxon. When first sent to me for identification I recognized it as possibly new but lacked fruiting material for descriptive purposes. George Hinton (son of the living Jaime Hinton, and grandson of the legendary plant collector, George B. Hinton) kindly sent me mature seeds nine years after its initial collection, these obtained from garden grown plants collected at the type locality. I am grateful to him for such diligence.

ACKNOWLEDGMENTS

I am grateful to my wife Gayle Turner for the Latin diagnosis and to Diane M. Ferguson and James S. Miller for helpful comments.

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Book Notice

Stanwyn G. Shetler and Sylvia Stone Orli. 2000. **Annotated Checklist of the Vascular Plants of the Washington - Baltimore Area. Part I: Ferns, Fern Allies, Gymnosperms, and Dicotyledons.** (no ISSN or ISBN). Department of Botany, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560-0166, U.S.A. Price not given, 186 pp [duplicated], 1 figure, 8 1/2" × 11".

Stanwyn G. Shetler and Sylvia Stone Orli. 2000. **Annotated Checklist of the Vascular Plants of the Washington - Baltimore Area. Part II: Monocotyledons.** (no ISSN or ISBN). Department of Botany, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560-0166, U.S.A. 95 pp [duplicated], 8 1/2" × 11".

The checklist in this pair of publications treats all native and naturalized species within the "Washington–Baltimore area," which represents a radius of about 50 miles from the Capitol in Washington, D.C. and includes the District of Columbia as well as 23 counties and 5 cities in Maryland and Virginia. "Species were accepted only on the basis of one or more voucher specimens in the D.C. Herbarium or a reliable published record" (the District of Columbia herbarium is a subunit of the US National Herbarium). As summarized in Part II, the documented D.C. flora now includes 1801 native species and 993 introduced species.

A related website (*http://www.nmnh.si.edu/botany/projects/dcflora/*) provides updates on the ongoing D.C. Flora Project and much other excellent information, including a bibliography, color photographs, spring-flowering records, links to useful sites related to the project, and a searchable Checklist database. The Checklist database returns full specimen data accessed by query to family, genus, species, collector, locality, state, or county. For example, an otherwise unrestricted query for Chenopodiaceae returned 148 records; a query for Asteraceae returned 7616 records; a query for Apiaceae in D.C. returned 183 records.—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX, 76102-4060, U.S.A.*

A NEW SPECIES OF *SCHISTOCARPHA* (ASTERACEAE: HELIANTHEAE) FROM NORTHWESTERN OAXACA AND CLOSELY ADJACENT GUERRERO, MEXICO

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ABSTRACT

Schistocarpha calzadana B.L. Turner, sp. nov., is described from south-central Oaxaca (Mpio. Santiago Juxtlahuaca) and south-central Guerrero, Mexico. It is closely similar to *S. bicolor* but can be distinguished by a number of features including those of the leaf, size and congestion of the capitulescence, and number and size of ray florets. A re-evaluation of the Mexican taxa has resulted in the submergence of *S. longiligula* into *S. platyphylla*. A revised key to the Mexican species is provided, along with maps showing their distribution.

KEY WORDS: *Schistocarpha*, Asteraceae, Mexico, Guerrero, Oaxaca

RESUMEN

Se describe ***Schistocarpha calzadana*** B.L. Turner, sp. nov., del centro sur de Oaxaca (Mpio. Santiago Juxtlahuaca) y centro-sur de Guerrero, México. Es muy semejante a *S. bicolor* pero puede diferenciarse por varios caracteres de la hoja, tamaño y aglomeración de la capitulescencia, así como el número y tamaño de las lígulas. Una re-evaluación de los taxa mexicanos ha dado como resultado la inclusión de *S. longiligula* en *S. platyphylla*. Se ofrece una clave revisada par alas especies mexicanas, junto con mapas de su distribución.

Schistocarpha is a mostly Mexican genus of ten closely related species (sensu Turner 1986 and the present paper). These have been variously interpreted (e.g, Rydberg 1927; Robinson 1979; Turner 1996), the most recent appraisal of the Mexican taxa, albeit for the state of Chiapas, being that of Strother (1999). With the exception of *S. eupatorioides* (Fenzl) O. Kuntze and *S. pedicellata* Klatt, Strother placed most of the Mexican species recognized by previous workers under the fabric of *S. bicolor* Less. Because of Strother's treatment I have looked again at the Mexican taxa and have concluded that one can reasonably sink the widespread, highly variable *S. longiligula* Rydb. into the earlier *S. platyphylla* Greenm., but the remainder of Strother's dispositions under a widespread *S. bicolor* is moot. Indeed, having gone over this taxonomic landscape anew I would still recognize six species as occurring in Mexico, including *S. liebmannii* Klatt, *S. matudinae* H. Rob., and the newly described *S. calzadana*, proposed below.

Schistocarpha calzadana B.L. Turner, sp. nov. (**Figs. 1, 2**). TYPE: MEXICO. OAXACA: Mpio. Santiago Juxtlahuaca, 17 km al SW de Santa Rosa sobre la carretera a San Miguel Cuevas



FIG. 1. *Schistocarpha calzadana*; isotype (TEX).



Fig. 2. Distributions of Mexican species of *Schistocarpha*.

y Manzanares (17 13 31.9 N, 98 03 24.4 W), 2150 m, 28 Feb 1995, *J.L. Panero 5524* (con Ismael Calzada) (HOLOTYPE: MEXU; ISOTYPES: TEX, UC).

Similis *S. bicolori* sed petioliis foliorum non articulatis basi, capitulescentia congestiore cum capitulis numerosis, et flosculis radii cum ligulis 1.5–2.5 mm longis (vice 3–6 mm).

Perennial, suffruticose herbs 1.5–2.5 m high. **Stems** moderately to densely pilose, glabrate with age. Larger **leaves** 20–30 cm long, 14–16 cm wide; petioles 6–8 cm long, winged throughout but much tapered below into a distinct petiole; blades broadly subcordate, markedly serrate, their apices rounded or obtuse. **Primary capitulescences** 14–20 cm across, ca. 10 cm high; ultimate peduncles mostly 3–9 mm long, pubescent like the stems. **Involucres** 4–5 mm high and about as wide, having imbricate 3–4 seriate bracts, the inner bracts scarious with mostly rounded ciliate apices. Receptacle plane or somewhat convex, paleate, the pales shorter than the subtended florets. **Ray florets** ca. 13 in a single series; tubes ca. 3 mm long; ligules white, 1.5–2.5(–3.0) mm long, ca. 0.8 mm wide, 2–4 nervate. **Disk florets** 30–40; corollas ca. 4 mm long, tubes ca. 2 mm long, glabrous or nearly so, the lobes 5, ca. 0.5 mm long, hispidulous without. **Achenes** of ray and disk similar, ca. 1.5 mm long, glabrous; pappus of numerous white bristles 3–4 mm long.

Additional collections examined: **MEXICO. GUERRERO:** "Along road between El Paraiso and Puerto del Gallo, 6.0–8.7 mi NE of El Paraiso. Moist tropical evergreen forest," 3500 ft, 9 Mar 1987, *Daniel & Bartholomew 4936* (CAS, TEX). **OAXACA:** Mpio. Santiago Juxtlahuaca, Km 14 de San Miguel Cuavas a El Manzal, desviacion en Santa Rosa (17 13 N, 98 03 W), 2300 m, 18 Feb 1995, *Calzada 19761C* (MEXU, TEX); 0.4 km del poblado El Manzanal, carretera a Infiernillo (17 13 N, 98 03 W), 2185 m, 8 Mar 1996, *Calzada 20784* (MEXU, TEX).

In the account of *Schistocarpha* by Robinson (1979), the present taxon will key to *S. matudae*, a species of southern Chiapas. In my treatment of the genus (Turner 1986), it will key to or near *S. liebmannii*, to which I originally referred the collections from Guerrero. With the newly collected Oaxacan material in hand, it seems likely that the several sheets relate better to *S. bicolor*, the latter from the Gulf Coast sierras, the former from the Pacific sierras. *Schistocarpha calzadana* differs from its more eastern cohort in characters as noted above.

It should be noted that Strother's (1999) treatment of *Schistocarpha* for the Asteraceae of Chiapas would reduce nearly all of the Mexican taxa of that genus (other than *S. eupatorioides* and *S. pedicellata*) to but a single widespread *S. bicolor*, including the present novelty. His comments to justify such reduction, "I have seen intermediate specimens that link all of the named extremes." seem exceedingly strained to me, especially since his examination of a wide range of collections at LL-TEX resulted in no annotations to that effect. I had no great difficulty in placing 'segregate' species names on the holdings at CAS, LL-TEX, and UC, most of which served as the basis for Strother's remarks. I have, however, accepted the likelihood that *S. longiligula* and *S. platyphlla* are synonymous, the two being largely sympatric and separated by relatively trivial features (ligule length and floret number). I also freely admit that *S. matudae*, *S. liebmannii*, and *S. calzadana* might be swept under *S. platyphylla*, as interpreted here (the earliest name for the complex then being *S. liebmannii*), but such tidying should take place only after more detailed field studies of the populations concerned. Regardless, *S. bicolor* (with its markedly winged petioles) does not extend so far south in Mexico so as to include the state of Chiapas.

Etymology.—The species is named for J.T. Calzada, a Mexican botanist who was the second worker to garner the taxon and who participated in all subsequent collections.

I include below a revised key to the Mexican species of *Schistocarpha*, which includes the present novelty. Figures two and three show the distributions of these taxa. The revised key and up-to-date distribution maps should prove helpful to future workers interested in the group.

KEY TO MEXICAN TAXA OF *SCHISTOCARPHA*

1. Pistillate florets (21–)30 80 in 2–4 series _____ **S. eupatorioides** (Fig 2)
1. Pistillate florets (3–)5–21 in a single series.
   2. Petioles conspicuously winged throughout, often expanding at the base and extending across the node; northeastern Mexico _____ **S. bicolor** (Fig 2)



Fig. 3. Distributions of Mexican species of *Schistocarpha*.

2. Petioles not broadly winged throughout, nearly always tapering onto a distinct cylindrical petiole; western and southern Mexico.
   3. Capitulescence lax, containing 8–12 heads on ultimate peduncles 2–5 cm long at maturity _____ **S. pedicellata** (Fig. 4)
   3. Capitulescence strict, congested, containing 30 or more heads on ultimate peduncles mostly 1.5–2.0(–2.5) cm long or less.
      4. Stems glabrate or nearly so at maturity; lower surface of blade (except for veins) glabrous, the upper surface somewhat darker than lower; disk florets 10–12, their corollas sparsely pubescent; montane cloud forests of north central Oaxaca and adjacent Veracruz _____ **S. liebmannii** (Fig. 3)
      4. Plants without the above combination of characters and distribution.
         5. Ray florets 5–12; ligules mostly 4–8 mm long _____ **S. platyphylla** (Fig. 4)
         5. Ray florets 12–21; ligules mostly 1–4 mm long.
            6. Involucral bracts with acute apices; southern Chiapas _____ **S. matudae** (Fig. 3)
            6. Involucral bracts with rounded apices; western Guerrero and Oaxaca _____ **S. calzadana** (Fig. 2)

With the exception of *S. calzadana*, all of the above-keyed taxa are treated in more detail by Turner (1986).



Fig 4. Distributions of Mexican species of *Schistocarpha*.

ACKNOWLEDGMENTS

I am grateful to my wife, Gayle Turner, for the Latin diagnosis and to Jose Panero for calling my attention to the Oaxacan plants concerned. John Strother reviewed an early draft of the manuscript, improving considerably its terseness and readibility. The study is based upon materials from the following herbaria: CAS, LL-TEX, UC, as follows: *Schistocarpha bicolor* CAS (22); LL-TEX (39); UC (7). *Schistocarpha liebmannii* CAS (4); LL-TEX (10); UC (1). *Schistocarpha matudinae* CAS (4); LL-TEX (3); UC (0). *Schistocarpha pedicellata* CAS (9); LL-TEX (15); UC (1). *Schistocarpha platyphylla* CAS (68); LL-TEX (54); UC (8).

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SENECIO SPRIBILLEI (ASTERACEAE: SENECIONEAE), A NEW SPECIES FROM MONTANA, U.S.A.

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ABSTRACT

Senecio spribillei W.A. Weber, a new, putatively narrow endemic species of Asteraceae, is described from a nunatak in the Rocky Mountains of northwestern Montana. It is distinguished from its nearest relative, *Senecio neowebsteri* Blake, by glabrous foliage, broader and shorter leaf laminae, wingless petioles, coarser marginal dentation, smaller, racemose capituli and minute ray flowers.

RESUMEN

Se describe ***Senecio spribillei*** W.A. Weber, una nueva especie endémica de Asteraceae, de un nunatak en las Montañas Rocosas del noroeste de Montana. Se diferencia de su pariente más próximo, *Senecio neowebsteri* Blake, por sus hojas glabras, lámina foliar más ancha y más corta, peciolos sin alas, dientes del margen con dientes más juntos, capítulos racemosos más pequeños y lígulas diminutas.

Senecio spribillei W.A. Weber, sp. nov. (**Fig. 1**). TYPE: U.S.A. MONTANA. Lincoln Co.: Cabinet Mountains, E face of Snowshoe Peak, ca. 150 m below the summit, N48°13'40" W115°40'40"; on sparsely vegetated alpine rock ledges, with *Dryas octopetala* and *Carex albonigra*, 2500 m alt., 25 Aug 2001, *Toby Spribille & M. Arvidson 11264* (HOLOTYPE: MO; ISOTYPE: COLO).

Herba perennis usque ad 2.0 dm alta, tota glabra, caudices brevi-ramosa, folia caulis juvenilis basalibus longepetiolatis 0.5 dm longis, folia basalibus caulis floriferis longepetiolatis 0.5 dm longis induviis, folia caulina 4–5, laminibus late triangulo ovatis vel subrotundis 3–4 × 2.5–3.0 cm longis et latis, truncatis vel ad basi brevissimo-cuneatis, grosse spinuloso-dentatis, petiolis non alatis, 4–5 cm longis, purpureis; capituli 4–6, nutantes, inferiore longe-pedunculata, involucris 8–10 mm altis, discis 5–7 mm diametris, phyllariis glabris lanceolatis obtusis late hyalinis, floribus radii paucis angustissimis.

Perennial from a well-developed, often branched caudex, up to 2 dm tall, totally glabrous; first year shoots 0.5 dm long, consisting of a few basal leaves on long petioles; flowering stem (second season) with withered basal leaves, cauline leaves with lamina broadly triangular-ovate to subrotund, 3.0–4.0 × 2.5–3.0 cm, truncate or very shortly cuneate at the base, coarsely spinulose-dentate, petioles scarcely winged, 4–5 cm long, purple; cauline leaves 4–5, similar to the basal leaves; heads 4–6, nodding, the lower on long, erect peduncles; involucre 8–10 mm high, the disk 5–7 mm diam, with a single row of phyllaries and a few minute basal bracteoles; phyllaries lance-oblong, obtuse or broadly acute, with broad hyaline margins, glabrous; ray flowers few, little exceeding the involucre, the lamina 7 × 2 mm, the veins 4–5, simple, the tube 4 mm long; disk flowers with limb 4 mm, tube 4 mm long; pappi 3 mm long; cypselae linear, strongly ribbed, 3 mm long.



FIG. 1. *Senecio spribillei,* holotype.

This new species is most closely allied with *S. neowebsteri* Blake (*S. websteri* Greenman, non Hook.), an endemic of the Olympic Mountains of Washington (Table 1). It appears to be a narrow endemic of northwestern Montana.

The ray flowers in the new species are so short and so narrow that the collector believed that the plant was rayless. The structural anatomy of the ray flowers differs from that of *Senecio neowebsteri*. In *S. spribillei* the nerves of the ray flowers are simple, unbranched; in *S. neowebsteri* each nerve is forked near the base, the branches continuing closely parallel distally. Baaghoe (1977, 1978) published on the taxonomic application of ligule micro-characters in the

TABLE 1. Comparison of *Senecio spribillei* and *Senecio neowebsteri*.

Senecio spribillei	Senecio neowebsteri
Foliage glabrous	Foliage initially floccose, then glabrate
Leaf lamina almost isodiametric, coarsely dentate, the base truncate	Leaf lamina usually longer than broad, variably dentate, the base cuneate
Petioles not winged	Petioles winged
Heads several, 6–8 mm tall, disk 5–7 mm diam	Heads solitary, 10–15 mm tall, disk 9–12 mm diam
Ligules of ray flowers 7–12 mm, hardly longer than the involucre	Ligules of ray flowers 25–30 × 3–5 mm, much longer than the involucre
Tubes of disk flowers 4 mm, limb 4 mm	Tubes of disk flowers 6 mm, limb 4 mm
Cypselae linear, strongly ribbed, 5 mm long	Cypselae linear. strongly ribbed, 3 mm long
Pappi white, 7 mm long	Pappi white, 3 mm long

Asteraceae but made no mention of venation or possible differences involving venation. Her work dealt with light and electron microscope observations, mostly on epidermal features. The existence of branched and non-branched nerves in *Senecio*, s. lat. deserves attention.

Distribution.—Known only from the type collection. According to the collector, the locality is likely a nunatak north of the southernmost limits of the Pleistocene ice sheets.

Etymology.—Senecio spribillei is dedicated to the young taxonomist and phytosociologist, Toby Spribille, with whom I have been associated for several years. His keen eye and ability to deal with the lichen and bryophyte as well as the phanerogamic flora, his knowledge of phytosociology, and his fine collections, marks him as an important figure in the recent history of the Rocky Mountain flora in Montana.

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Book Notices

Charles M. Allen, Dawn Allen Newman, and Harry H. Winters. 2002. **Trees, Shrubs, and Woody Vines of Louisiana.** (ISBN 0-9718625-0-8, pbk). Allen's Native Ventures, LLC, 5070 Hwy 399, Pitkin, LA 70656, U.S.A. (Orders: 337-328-2252, native@camtel.net). Price not given, 333 pp, numerous b/w line drawings, 3 maps, 5 1/2" × 8 1/2".

This book provides information on 414 species that are native and naturalized and, in a number of cases, cultivated and persisting. The entries are listed alphabetically (by scientific name, sans author) by genus and species. A long paragraph on each of the species gives common names, name derivations, morphological features, and medicinal, economic, historical, and wildlife uses. The last sentence of each paragraph notes the distribution in Lousiana: e.g., "It is widely distributed throughout the state but more commonly in sandy soil (FAC) along the coast with reports from 18 parishes" (*Cissus trifoliata*); "In swamps, edges of lakes, ponds and other water bodies (OBL) with current reports from 46 parishes" (*Nyssa aquatica*); "Widely cultivated and escaping and forming dense thickets; this species is a serious pest in many parts of the state (FAC)" (*Ligustrum sinense*); "The current records, mostly from cultivated plants, include seven parishes" (*Photinia serratifolia*); "Planted throughout the state (FACU) as an ornamental with some recent interest in its wood. The current records include 14 parishes" (*Paulownia tomentosa*). Apart from the enumeration of which woody species occur in the state and their reproductive status, perhaps the most useful feature of the book is the line drawing for each species, drawn from a range of previously published sources. Identification keys are not provided but 8 'tables' in the introductory material list genera with distinctive characters such as strong odor, compound leaves, opposite or whorled leaves, etc. This compilation will serve good use as a reference in company with an identification manual and range maps.—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX, 76102-4060, U.S.A.*

John Graves, Photos by Wyman Meinzer. 2002. **Texas Rivers.** ISBN 1-885696-38-8, hbk.) University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (Orders 800252-3206 512-471-4032, 800-687-6046 fax)) $39.95, 144 pp.80 color photos, 11" × 11".

If *Texas Rivers* were only a picture book it would be an outstanding work. The photographs by Wyman Meinzer are breathtakingly beautiful. Panoramas and close-ups alike are full of radiant color and telling detail. Each captures the essence of the particular area through which the river flows.

The text by John Graves is also complete in itself, a testament to the beauty and diversity and total utility of Texas rivers. He touches on all aspects of riverine territories from their archeology, botany, climate, economy through the alphabet of scientific studies to zoology. It is as if one is taking a leisurely walking tour along the river with a very knowledgeable friend with time to stop to appreciate the great and small wonders of this multifarious land.

Together these two artists have created a very beautiful book, a welcome addition to an library.—*Ruth Ginsburg, Fort Worth, Texas.*

EUCHITON (ASTERACEAE: GNAPHALIEAE) IN NORTH AMERICA AND HAWAII

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ABSTRACT

Euchiton is treated apart from *Gnaphalium* primarily on the basis of its tendency for stolon production and cypselar surfaces with paired, non-mucilaginous epidermal papillae. Three species of *Euchiton* are recorded in North America: *E. sphaericus* (naturalized in California and Oregon), *E. gymnocephalus* (naturalized in California and Oregon), and *E. involucratus* (apparent waif in California and Massachusetts, the first published report of this species in North America). The first two species also are naturalized in Hawaii. A nomenclatural and ecological summary is presented for each species and a key clarifies their identifications, which have been confused in North America.

RESUMEN

Euchiton Se trata como diferente de *Gnaphalium* primariamente en base a su tendencia a la producción de estolones y superficie de las cipselas con papilas epidérmicas pareadas y no mucilaginosas. Se han citado tres especies de *Euchiton* en Norte América: *E. sphaericus* (naturalizada en California y Oregón), *E. gymnocephalus* (naturalizada en California y Oregón), y *E. involucratus* (aparentemente abandonada en California y Massachusetts, es la primera cita de esta especie en Norte América). Las dos primeras especies están también naturalizadas en Hawaii. Se presenta un resumen nomenclatural y ecológico de cada especie y una clave clarifica sus identificaciones, que han sido confusas en Norte América.

Euchiton is treated apart from *Gnaphalium* primarily on the basis of its tendency for stolon production and cypselar surfaces with paired, non-mucilaginous epidermal papillae (Anderberg 1991). The plants are mostly perennial and produce heads in terminal, capitate clusters immediately subtended by a whorl of leafy bracts. The distinctiveness of the group was emphasized by Drury (1972) and Holub (1974); nomenclatural transfers to *Euchiton* were made by Holub (1974) and completed by Anderberg (1991) and Ward and Breitwieser (1998). The species number about 22 (Drury 1972; Anderberg 1991), including recent additions (Buchanan 1999, Walsh 1999) or 20–30 (Walsh 1993). They are native to Australia and New Zealand and probably to New Guinea and eastern Asia; some species have weedy tendencies and have become widely naturalized.

The following synopsis of *Euchiton* in North America and Hawaii is based on surveys of collections at ARIZ, BRIT-SMU, CAS-DS, GH, HSC, MO, NCU, TEX-LL, UC-JEPS, and WIS.

Euchiton Cass. in F. Cuvier, Dict. Sci. Nat. ed. 2, 56:214. 1828. TYPE SPECIES: *Euchiton pulchellus* Cass.

= *Euchiton involucratus* (G. Forster) Holub

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Plants perennial or (less commonly) annual, herbaceous, stoloniferous in most species (taprooted in 1), white-tomentose, eglandular. **Leaves** basal and cauline, sometimes in a rosette, lanceolate to linear, entire, sessile or petiolate, bicolored, usually with a close tomentum at least on the abaxial surfaces. **Capitulescences**: heads usually in a terminal cluster subtended by a whorl of leafy bracts, sometimes with axillary clusters below. **Capitula** narrowly campanulate to short-cylindric; phyllaries chartaceous, transparent, inner with larger stereomes. **Pistillate florets** fertile, more numerous than the bisexual florets, corollas purple or purple-tipped. **Bisexual florets** fertile, corollas purple or purple-tipped. **Cypselae** oblong, 0.6–1.5 mm, epidermis minutely papillate (the papillae imbricate and paired, nonmyxogenic); pappus of caducous, separate or weakly basally connate bristles separating in groups. Base chromosome number, $x = 14$.

1. Annual, taprooted; leaves not at all clasping or sheathing; capitula in a globose cluster; bisexual florets 1 per capitulum; capitulescence bracts 4–8. _____ **Euchiton sphaericus**
1. Perennial or biennial, fibrous-rooted; leaves subclasping or sheathing; capitula in a hemispheric cluster; bisexual florets 3–7 per capitulum; capitulescence bracts 2–5.
   2. Stolons commonly present, plants forming colonies; basal leaves present in a rosette at flowering; cauline leaves 2–4(–6), linear to oblanceolate, 0.5–3(–4) cm long, 1–3 mm wide; pistillate florets 40–60; capitulescence bracts 2–3, not exceeding the capitulescence or only slightly so. _____ **Euchiton gymnocephalus**
   2. Stolons usually absent, plants not evidently colonial; basal leaves usually withered or absent at flowering; cauline leaves 6–10, mostly linear, 3–8 cm long, 2–3 mm wide; pistillate florets 80–150; capitulescence bracts 3–5, distinctly longer than the capitulescence. _____ **Euchiton involucratus**

1. Euchiton gymnocephalus (DC.) Holub, Folia Geobot. & Phytotax. 9:271. 1974 [non (DC.) A. Anderberg 1991]. *Gnaphalium gymnocephalum* DC., Prodr. 6:235. 1838. TYPE: AUSTRALIA.

Gnaphalium collinum Labill., Nov. Holl. Pl. 2:44, t. 189. 1806. *Gnaphalium japonicum* var. *collinum* (Labill.) Maiden & Betche, Census New South Wales Pl. 204. 1916. TYPE: AUSTRALIA.

Flowering (late March–)May–October(–November). Grassy hills, margins and openings in woods, roadsides, cutover areas; ca. 100–2500 ft (30–750 m); California and Oregon, Hawaii. Apparently native to Australia and New Zealand. Recorded in Australia as "common and widespread, particularly in cooler parts ..., often colonizing bare ground, stream and track margins etc." (Walsh 1993, p. 823) and "woodland areas near Canberra and also extending to upper slopes of mountains; widespread in many parts of Australia and Tasmania" (Burbidge & Gray 1970). In New Zealand, it occurs in a wide variety of habitats but is "typically associated with forest and scrub communities between sea level and 1,000 (–2,000) ft" (Drury 1972, p. 144).

A handwritten note by J.P. Tracy on the JEPS sheet of *Tracy 14110* notes the following: "My record of this plant [*Euchiton gymnocephalus*, presumably in Humboldt County] extends back to 1900 when it was already well estab." Cita-

tions below indicate that Tracy collected the species repeatedly in Humboldt County from 1904 through 1946 and collections between 1960 and 1989 have continued to document its occurrence in counties of northeastern California and southeastern Oregon.

Collections examined. **UNITED STATES. California. Del Norte Co.:** 3 mi S of Klamath River, grassy hills near coast, 300 ft, 12 May 1929, *Tracy 8588* (CAS, UC). **Humboldt Co.:** near Azalea Reserve State Park, cool woods in partial shade, 100 ft, 15 Jul 1960, *Adams s.n.* (HSC); along Mad River ca. 2 mi S of Blue Lake, 28 Jun 1971, *Anderson* and *Smith J-1230* (HSC); 8 mi W of Berry Summit along US 299, 2500 ft, roadcut on serpentine soil, 15 May 1965, *Bos 254* (HSC); Lord Ellis road near Shingle Mill, 28 Mar 1926, *Kildale 1670* (DS); Lord Ellis road near Blue Lake, 25 Nov 1926, *Kildale 2830* (DS); Trinidad, Camp Twenty One, 600 ft, 30 Jul 1932, *Parks and Tracy 1133* (UC); above dirt road from old 101 to the top of the N bank of the Mad River, grassy hillside in half shade, 22 Jul 1967, *Stevens 61* (HSC); Garberville Quad., old skid road, shady edge of redwood forest and mixed evergreen forest, 850 ft, moss-covered rocky subsoil, 13 Aug 1976, *Sutherland 9.13.8.76* (HSC); Shubrick Peak Quad., Kinsey Ridge above Oat Creek, logged doug fir forest, 24 Apr 1978, *Sutherland 6.24.4.78* (HSC); immediate vicinity of Eureka, small patches in open places in woods, 0–500 ft, 31 Jul 1904, *Tracy 2134* (CAS, DS, GH, UC); Boynton Prairie road, near Carroll place, 1000 ft, 23 Jun 1918, *Tracy 4958* (NCU, UC); near Blue Lake, in woods, spreading by stolons and forming patches, 1000 ft, 1 Apr 1923, *Tracy 6175* (JEPS, UC); near Boynton Prairie, in recently logged area, among "fireweeds," 2000 ft, 28 Aug 1927, *Tracy 8358* (UC); Trinidad, logged-off lands, spreading in mats, 10–200 ft, 13 Aug 1932, *Tracy 10349* (ARIZ, CAS, UC); near Blue Lake, roadside in open woods on Trinity Hwy, spreading and forming mats, 900 ft, 20 Jul 1935, *Tracy 14110* (CAS, JEPS, UC-2 sheets); 4 mi SE of Korbel, near "Angels Ranch," local in grassy moist places, 1000 ft, 22 Mar 1936, *Tracy 14784* (CAS, DS, JEPS, UC-2 sheets); Fickle Hill, 6 mi SE of Arcata, in recently cleared land, 2000 ft, 17 May 1936, *Tracy 14811* (UC); 2 mi NE of Orick, on Bald Hills road, local by roadside, 500 ft, 29 May 1936, *Tracy 14829* (CAS, DS, GH, JEPS, UC); hillsides near Canyon Creek, 6 mi SE of Blue Lake, in logged-over land, 1200 ft, 1 Aug 1936, *Tracy 15058* (UC); Carlotta, in recently logged area, with [*Gamochaeta ustulata*] and [*Euchiton sphaericus*], 100 ft, 23 Aug 1936, *Tracy 15164* (UC); Fickle Hill, 6 mi SE of Arcata, in country recently logged, 2000 ft, 24 Aug 1936, *Tracy 15175* (UC); vicinity of Carlotta, in recently cleared land, ca. 100 ft, 15 Jun 1938, *Tracy 15936* (UC); "Riverside Park" near old Strong's Station District School House (burned down), 30 May 1946, *Tracy 17548* (UC); Kneeland Prairie, Dan McBride's place (SE end of Kneeland), local, in partial shade of open fir woods, 2500 ft, 23 Jun 1946, *Tracy 17596* (UC). **Mendocino Co.:** 15 air mi SW of Garberville, 60 air mi SSE of Eureka, 1/4 mi E of Bear Harbor on Lost Coast Trail, edge of trail bed, California bay riparian forest, 120 ft, 8 Jul 1989, *Bowcutt 1369* (HSC); 3.2 km N of jct with Rte 1, along Usal Rd, openings in second growth redwoods, 305 m, 11 Jun 1981, *Smith 6632* (CAS, HSC). **Siskyou Co.:** Forest Service Road 17NO4, Doe Flat, T17N, R4E, Sec. 35, [no date], *Van Deventer s.n.* (HSC). **HAWAII.** Hawaii, Upper Waiakea Forest Reserve, along Disappointment Trail (Pu'u Maka'ala access rd.) of Stainback Hwy., in *Metrosideros* rainforest, ca. 1100 m, 26 Jul 1983, *Wagner et al. 4842* (US). **OREGON. Curry Co.:** on old segment of Hwy 101 that leads as a dead-end from Harris Beach State Park, just N of Brookings, 10 Jun 1964, *Chambers 2241* (DS, NCU); Brookings, 100 ft, 1 Aug 1937, *Tracy 15606* (UC); moist slope 5 mi N of Brookings, 7 Jul 1939, *Peck 20445* (CAS, UC). **Klamath Co.:** Winema National Forest, Cold Springs Road and State Route 140, T36S R6E, Sec. 18, 14 Oct 1978, *Sawyer 3320* (HSC).

Wagner et al. (1997) recorded *Euchiton gymnocephalus*, identified as *E. japonicus* (Thunb.) Holub, as a new state record for Hawaii. In Australia it was identified as *Gnaphalium japonicum* Thunb. by Burbidge and Gray (1970), but the synonymy of *G. japonicum* with *G. gymnocephalum* was later rejected without specific comment by Cooke (1986) and Walsh (1993). In the present review, plants

from Japan and China appear to be consistently distinct from related ones of Australia and New Zealand, although differences are subtle, and until someone may provide a more detailed study of the complex, the morphological affinity of the North American plants with those of Australia is reinforced by the nomenclature. Differences between the two taxa are outlined in the following couplet.

Basal leaves usually narrowly oblanceolate, attenuate to a distinct petiolar portion, the cauline abruptly differentiated in size and shape from the basal, smaller and linear-lanceolate to linear-oblanceolate; adaxial leaf surfaces quickly glabrescent and shiny-green; stereome thickened and opaque, distinctly narrowed apically and separated from the lamina by a short, completely translucent portion; cypselae ca. 0.7 mm long. ____ **Euchiton gymnocephalus**

Basal and cauline leaves linear lanceolate to linear oblong, without a distinct petiolar portion, the lower cauline slightly reduced in size but similar in shape to the basal; adaxial leaf surfaces persistently arachnoid, appearing dull; stereome thin-translucent, not evidently narrowed apically, more or less directly connected to the lamina; cypselae ca. 1.0 mm long. ____ **Euchiton japonicus**

Plants from Japan, China, and Taiwan (specimens examined), and probably from Ryukyus and Korea are typical *E. japonicus* (see citation below). Collections referable to *E. japonicus* or *E. gymnocephalus* from New Guinea, New Caledonia, and Java need to be studied in order to assess their relationship. Reports of *E. japonicus* from the Philippines evidently refer, at least in part, to *Gnaphalium oblanceolatum* Elmer, which apparently is more closely related to *E. involucratus* (but probably not conspecific with it) than to *E. japonicus*.

Euchiton japonicus (Thunb.) Holub, Folia Geobot. & Phytotax. 9:271. 1974 [non (Thunb.) Anderb. 1991]. *Gnaphalium japonicum* Thunb., Fl. Jap. 311. 1784. TYPE: JAPAN ("prope urbem Nagasaki").

2. Euchiton involucratus (G. Forster) Holub, Folia Geobot. & Phytotax. 9:271. 1974 (non A. Anderberg 1991). *Gnaphalium involucratum* G. Forster, Fl. Ins. Austr., 55. 1786. TYPE: NEW ZEALAND

Flowering July–October. Grassy open places, often moist or wet; ca. 50–600 m; California and Massachusetts. Native to Australia and New Zealand; collections also observed (present study) from New Guinea, New Caledonia, Java, and Taiwan. The species in Australia is recorded as a "weed of gardens and disturbed ground" (Burbidge & Gray 1970); it also is common "particularly in swampy sites, from near sea-level to the higher alps where usually in *Sphagnum* bogs" (Walsh 1993).

Both of the North American collections cited below probably represent waifs, because this species apparently has not been subsequently recorded in floristic summaries from anywhere in the USA. This apparently is the first published report of *E. involucratus* from North America.

Collections examined. **UNITED STATES. California. Humboldt Co.:** S end of Fickle Hill, 6 mi SE of Arcata, ca. 2000 ft, moist ground, among rushes and sedges, spreading by rootstocks, perennial, 26

Sep 1948, *Tracy 18232* (ARIZ, NCU, UC-2 sheets, WIS). **Massachusetts. Hampshire Co.:** Northampton, weed in garden, Sep 1900, *Mrs. E.H. Terry s.n.* (GH).

3. Euchiton sphaericus (Willd.) Holub, Folia Geobot. & Phytotax. 9:271. 1974 (non A. Anderberg 1991). *Gnaphalium sphaericum* Willd., Enum. Hort. Berol. 2:868. 1809. TYPE: AUSTRALIA.

Gnaphalium involucratum G. Forster var. *simplex* DC., Prodr. 6:236. 1838. Based on *G. sphaericum*.
Gnaphalium involucratum G. Forster var. *ramosum* DC., Prodr. 6:236. 1838. TYPE: AUSTRALIA.
Gnaphalium morii Hayata, Ic. Pl. Formos. 8:58. 1919. TYPE: Taiwan ("Formosa").
?Leontopodium japonicum (Thunb.) H. Lév. var. *sandwicense* H. Lév., Fedde Repert. 10:121. 1911. TYPE: HAWAII.
Gnaphalium japonicum sensu various authors, non Thunberg 1784.

Flowering (late June, *Tracy 15974*; July–)August–October. Grassy open places in wooded areas, recent clearings and clearcuts, disturbed soil, especially along roadsides; ca. 100–2000 ft [30–600 m]; California and Oregon, Hawaii (Molokai, Lanai, Maui, and Hawaii, fide Wagner et al. 1999). "Reported from San Joaquin County," California (Ferris 1960; voucher not seen in present study). Native to Australia and New Zealand; also documented from New Guinea, New Caledonia, Java, Philippines, Japan, and Taiwan (Drury 1972). In Australia recorded as "a very common and widespread species, occurring on a wide variety of substrates, e.g., mallee and coastal sands, clayey floodplain area, and often colonizing disturbed ground" (Walsh 1993).

Euchiton sphaericus has long been identified in California, apparently beginning with Howell (1937), as *Gnaphalium japonicum*; it recently was correctly identified by Wagner et al. (1997) and by Peter W. Michael (annotations on specimens at GH). Correct nomenclature was earlier provided by Drury (1972). *Euchiton sphaericus* was established in California at least by 1915, when apparently first collected there. J.P. Tracy collected it repeatedly from that year through 1949; from one locality (*Tracy 14752*) he noted that it was "scarce now, abundant 15 years ago." Tracy also observed (fide label of *Tracy 5097*) that the species was "probably introduced in grass seed sown on logged-over country." Relatively recent collections (1954, 1977, 1992) confirm its persistence in northwestern California.

Euchiton sphaericus was collected in Hawaii, perhaps for the first time, in 1909 (on Maui, *Faurie 928*–BISH, as noted by Wagner et al. 1999). Rock (1914, p. 352) noted that in Hawaii *E. sphaericus* was among several species "imported accidentally during the last 10 or 20 years, by the cattle estates with grass seeds."

Collections examined. **UNITED STATES. California. Del Norte Co.:** Sutton Creek, 2 mi E of the Van Deventer Ranch and 2.5 mi air-line E of Fort Dick, 350 ft, 15 Oct 1954, *Van Deventer 412* (UC). **Humboldt Co.:** Eel River, 16 mi N of Garberville, 29 Aug 1936, *Howell 12888* (GH, LL, WIS); logged redwood flat, 2 mi E of Carlotta, 15 Aug 1936, *Jepson 17,898* (JEPS); mouth of Laribee Creek, common as a weed but local, 200 ft, 12 Sep 1915, *Tracy 4677* (CAS, MO, UC); around Humboldt Bay, Newells Camp on old Kneeland Prairie road, probably introduced in grass seed sown on logged over country, 1500 ft, 1 Sep 1918, *Tracy 5097* (NCU, UC-2 sheets); South Fork of Eel River, 4 mi above the mouth, common road-

side weed, 200 ft, 29 Sep 1918, *Tracy 5103* (TEX, UC); at Eureka, introduced along old road in stump land, 0–200 ft, 6 Oct 1918, *Tracy 5118* (UC); North Fork of Mad River, along newly constructed road, evidently introduced and not yet common there, 1000 ft, 19 Sep 1920, *Tracy 5399* (UC); South Fork of Eel River, near Miranda, 300 ft, 9 Aug 1925, *Tracy 7229* (UC); along Lord-Ellis Road, headwaters of North Fork of Mad River, scarce, 2000 ft, 8 Aug 1931, *Tracy 9608* (UC); near Dyerville, roadside weed, scarce now, abundant 15 years ago, 300 ft, Sep 1935, *Tracy 14752* (UC), Carlotta, locally abundant as a "fireweed" in recently cleared land, 100 ft, 23 Aug 1936, *Tracy 15162* (GH, HSC-2 sheets, MO, TEX, UC-3 sheets, WIS); Fickle Hill, 6 mi SE of Arcata, restricted to land recently cleared and soil disturbed, 2000 ft, 24 Aug 1936, *Tracy 15176* (GH, JEPS, UC); Trinity River Valley, at Willow Creek, weed in garden, not common, 500 ft, 20 Jun 1938, *Tracy 15974* (UC); Trinity River Valley, along new road to Hors Linto Creek, disturbed soil, 800 ft, 4 Sep 1938, *Tracy 16142* (UC); Trinity River Valley, near Raccoon Creek, moist ground disturbed by road work, 500 ft, 11 Aug 1940, *Tracy 16694* (JEPS, LL-2 sheets, UC); Valley of South Yager Creek, recently logged land as a 'fireweed' on the Redwood House Road at old mill site, 1 mi N of Redwood House, 1500 ft, 26 Jul 1942, *Tracy 17299* (UC); Park's place, 10–200 ft, 28 Sep 1947, *Tracy 17933* (UC); Fickle Hill, 6 mi SE of Arcata, recently logged area, scarce, ca. 2000 ft, 26 Sep 1948, *Tracy 18230* (UC); Van Duzen River, near Grizzly Creek, frequent in disturbed soil of recent logging operations, 300 ft, 16 Oct 1949, *Tracy 18591* (UC, WIS); Aikens Campground, T10N R5E, Sec. 30, mixed evergreen forest, 1 Jul 1977, *Sawyer 2990* (HSC). **Lake Co.:** road to Bartlett Mountain, Aug 1930, *Mason 5732* (UC). **Mendocino Co.:** 10 air mi W of Leggett, along and in dirt roadbed of Hotel Gulch Road 5.3 road mi from Usal, S-facing slope, coast redwood/douglas fir forest logged about 15–20 years ago, 21 Jul 1992, *Bowcutt 1571* (HSC), Mendocino Woodlands, 10 Jul 1938, *Eastwood and Howell 6238* (UC). **Trinity Co.:** Sharber Slough on the Trinity River, 3 mi E of the South Fork, along trail, sparsely introduced in moist ground, 6 Sep 1926, *Tracy 7783* (CAS, UC). **HAWAII. Hawaii:** Hawaii National Park, Kilauea Crater, on dry lava, 18 Jul 1931, *van Löben Sels 595* (UC); Waimea Mts., Jun 1910, *Rock 8433* (GH); Hawaii National Park, weed on xeric cinder flats in Kau Desert near Halemaumau, 3600 ft, 18 Jun 1948, *Webster* and *Wilbur 1793* (TEX). **Lanai:** Mts., E end, Jun 1913, *Forbes 276.2* (UC). **Maui:** Koolau Gap, Haleakala, volcanic cinders, 10 Aug 1927, *Degener 18451* (GH); Haleakala, 16 Aug 1927, *Degener 18450* (GH); Olinda, Pipe-Line Trail, 30 Jul 1927, *Topping s.n.* (GH); Haleakala, Aug 1909, *Faurie 928* (BISH, as cited by Rock 1914 and Wagner et al. 1999; not seen). **OREGON. Curry Co.:** dry ground along Chetco River, 3 mi above Harbor, 20 Jul 1919, *Peck 8924* (GH).

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Book Notice

Dennis Blagg. 2002. **Big Bend Landscapes**. (ISBN 1-58544-202-X, hbk.). Texas A&M University Press. John H. Lindsey Building, Lewis Street, 4354 TAMU, College Station, TX 77843-4354, U.S.A. (Orders: www.tamu.edu/upress, 979-458-3982, 800-826-8911, 979-847-8752 fax). $40.00, 160 pp, 50 color paintings, 15 b/w drawings, 12 1/4" × 9 3/4".

Ron Tyler's introduction to *Big Bend Landscapes* is a succinct history of the region from Indian times to the creation of a public park in a portion of this great wilderness. He also traces the rise of the Romantic movement and the enthusiasm for landscape painting as a result of the awe-inspiring expanses and mountains of the West. The Big Bend country is certainly a manifestation of the 'untarnished handwork of the Creator'.

This essay is a fitting preface to the fifty paintings and nineteen drawings which are reproduced here in beautiful color. The diversity of the country, the effect of light, and the astonishing formations of rocks and clouds are very well portrayed. In the vast panoramic views, the details are astonishing. The short explanations which accompany each picture are interesting and add a personal note. But the paintings speak for themselves. They convey a spirituality and a passion for nature. The artist is a worthy successor of such giants of American landscape painting as Cole, Durand, Church, Kensett, and Bierstadt.—*Ruth Ginsburg, Fort Worth, Texas.*

Wilfrid Blunt with an introduction by William T. Stern. 2001. **Linnaeus. The Compleat Naturalist.** (ISBN 0-691-09636-8, hbk.). Princeton University Press, 41 William Street, Princeton, NJ 08540, U.S.A. (Orders: California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A., 609-883-1759, 609-883-7413 fax, www.pup.princeton.edu). $35.00, 264 pp., color photos, b/w photos, line drawings, maps, 7 5/8" × 9 7/8".

What a beautiful book and what a wonderful way to remember William T. Stearn (1911–2001). The book, originally titled *The Compleat Naturalist: A Life of Linnaeus*, is published in his memory. The following description of the book is an extract from the dust jacket. "This book gives a fascinating and rounded portrait of Linnaeus the man, charting his rise from a poor student at Lund University to Professor of Medicine at Uppsala and a founder of the Royal Academy of Sciences. Wilfrid Blunt's engaging text is interspersed with vivid passages from his subject's own writings—from riveting descriptions of adventures in the wilds of Lapland to a charming account of Sjupp the raccoon. Linnaeus's family life and his relations with pupils are explored alongside his epoch-making scientific achievements. William Stearn's appendix on Linnaean classification provides a concise survey of the basics necessary for understanding Linnaeus's work."

NEW COMBINATION IN *SALIX* (SALICACEAE)

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Dorn (1998; following Cronquist 1964) has treated *Salix interior* Rowlee at infraspecific rank within *S. exigua* Nutt., observing that a broad region of morphological intergradation exists between the two where their ranges are in contact (see Dorn's Fig. 2, p. 200). This observation is confirmed in field studies relating to a floristic inventory of Lake Meredith National Recreation Area in Hutchinson, Moore, and Potter counties of the north-central Texas panhandle (Nesom & O'Kennon in progress). In this area many populations exist of *S. interior* sensu stricto (colonial shrubs with completely glabrous, linear-lanceolate leaves with widely spaced and elongate teeth) as well as *S. exigua* (similar to *S. interior* but with densely silky-sericeous lower leaf surfaces). Also common are populations with foliar vestiture in varying degrees of intermediacy (e.g., *Nesom & O'Kennon LM359, LM198* – BRIT). *Salix nigra* Marsh and *S. amygdaloides* Anderss. also commonly occur in the area, apparently without intergrades.

Argus (1986) treated *Salix exigua* as including *S. interior* without formal rank, but he noted (p. 91) that the "eastern phase (*S. interior*) differs from the western phase (*S. exigua*) in having leaves less densely sericeous, more distinctly toothed, and more veiny." In my observation (based on BRIT and VDB collections), variability in vestiture is greater in the western phase than in the eastern phase, where the green-glabrous leaves are consistently evident. Sericeous undersurfaces are characteristic of the western phase.

Dorn recognized three varieties within *Salix exigua* subsp. *exigua* but treated *S. interior* only at subspecific rank: *S. exigua* subsp. *interior* (Rowlee) Cronquist. The following combination provides consistent nomenclatural recognition of all infraspecific taxa, following ICBN Article 4.1: "The secondary ranks of taxa in descending sequence are tribe (tribus) between family and genus, section (sectio) and series (series) between genus and species, and variety (varietas) and form (forma) below species" (see commentary in Turner & Nesom, Sida 19:257–262. 2000).

Salix exigua var. **sericans** (Nees) Nesom, comb. nov. BASIONYM: *Salix longifolia* var. *sericans* Nees in Wied-Neuw., Reise Nord-America 2:448. 1841. TYPE: not seen.

This is the oldest available name at varietal rank for plants identified as *Salix interior*. As noted by Dorn (1994, p. 92), the type locality apparently is "in or near the present Cass Co., Nebraska" (eastern Nebraska, well within the range of typical *S. interior* and east of the area of its co-occurrence with *S. exigua* var.

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exigua, although the epithet implies that the leaves probably were not completely glabrous.

ACKNOWLEDGMENTS

Comments by George Diggs and an anonymous reviewer are appreciated.

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TAXONOMY OF THE MOST COMMON WEEDY EUROPEAN *ECHINOCHLOA* SPECIES (POACEAE: PANICOIDEAE) WITH SPECIAL EMPHASIS ON CHARACTERS OF THE LEMMA AND CARYOPSIS

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ABSTRACT

The most common weedy *Echinochloa* species in Europe—*E. colona* (L.) Link, *E. crus-galli* (L.) Beauv., *E. hispidula* (Retz.) Nees ex Royle, *E. oryzoides* (Arduino) Fritsch, *E. oryzicola* (Vasing.) Vasing. are for the first time analyzed regarding the micromorphology of lemma and caryopsis, the anatomy of the caryopsis and the size of the starch grains. New potentially valuable characters are the size of the caryopsis, the pattern of surface variation of the caryopsis coat, and the size of the starch grains. A cautionary approach is suggested towards the taxonomic utility of the silica bodies shape. Based on the new characters, the relationships between the species are analyzed. Some nomenclatural issues involving *E. oryzicola*, *E. oryzoides*, and *E. hispidula* are also discussed. For the first time, *E. colona* is recorded from Romania.

RESUMEN

Las especies más comunes de *Echinochloa* en Europa que son *E. colona* (L.) Link, *E. crus-galli* (L.) Beauv, *E. hispidula* (Retz.) Nees ex Royle, *E. oryzoides* (Arduino), Fritsch, *E. oryzicola* (Vasing.) Vasing. han sido analizadas por primera vez mediante micromorfología del lemma y del cariópside, la anatomía del cariópside y por el tamaño de los granos de almidón. Los nuevos caracteres que se pueden considerar de gran valor son el tamaño del cariópside, la variación en el patrón de la superficie de la cubierta del cariópside y el tamaño de los granos de almidón. No se sugiere como herramienta taxonómica la forma de los cuerpos silíceos. Basándose en los nuevos caracteres, se analiza la relación entre las especies. Algunos tópicos de nomenclatura que involucran a *E. oryzicola*, *E. oryzoides* y *E. hispidula* son también discutidos. Por primera vez *E. colona* se cita de Rumania.

INTRODUCTION

Echinochloa is an economically important genus because many of its species are noxious weeds. In Europe, *E. hispidula*, *E. oryzoides* and *E. oryzicola* are most often found as weeds in rice fields while *E. crus-galli* and *E. colona* although present in rice fields, are more often encountered in irrigated fields and amongst vegetable crops (Kossenko 1947; Vasconcellos 1954; Pirola 1965; Chirilă 1984; Tzvelev 1976; Häflinger & Scholz 1980; Carretero 1981; Mosyakin 1996; Ciocarlan 2000). The taxonomy of the genus is controversial due to nomenclatural prob-

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lems and the continuous morphological variation exhibited by the taxa. For the practical purpose of plant identification, the species often lack conspicuous identification characters. Previous treatments and taxonomic studies are often contradictory and, consequently, the limits of the taxa are uncertain and specimens in herbaria are often misidentified. Other important taxonomic treatments of the genus (or part of the genus) are those of Stapf (1899, 1934), Hitchcock (1920), Wiegand (1921), Kossenko (1947), Ohwi (1942, 1962), Martinez Crovetto (1942), Vasconcellos (1954), Bor (1960), Pirola (1965), Chirilă (1967, 1984), Yabuno (1962, 1981), Ali (1968), Gould et al. (1972), Tzvelev (1976), Häflinger & Scholz (1980), Clayton (1980), Carretero (1981), Michael (1983) and Brussoni (1994). A general characterization of the genus can be found in Watson and Dallwitz (1992–onwards). Carretero (1981) provided a summary of the morphologic characters for European weedy species of the genus *Echinochloa*.

The identification of new characters useful in determining taxonomic boundaries have shed light on our understanding of difficult groups such as grasses. The study of lemma micromorphology can provide characters valuable in elucidating the delimitation of taxa, and these characters may reflect systematic relationships. Micromorphological features of glumes and bracts (lemma and palea) have been studied in other genera from *Poaceae* by: Bjorkman (1960), Hsu (1965), Baum (1971), Lucas (1979), Clark and Gould (1975), Thomason (1978a; 1978b, 1980, 1981, 1986), Shaw and Smeins (1979), Terrel and Wergin (1981), Terrel et al. (1983), Webster and Hatch (1983), Barkworth (1983), Peterson (1989), Soderstrom and Zuloaga (1989), Kellogg (1990), Zuloaga and Judziewicz (1991), Valdes-Reyna and Hatch (1991), Molina (1993), Naredo et al. (1993), Ball et al. (1993, 1999) and Snow (1996, 1998).

Caryopsis morphology has received a lot of attention since the beginning of the century; however, most studies have focused on the general morphology and the structure of the embryo. There is comparatively less information available on the anatomy of the caryopsis coat in various other grasses (Netolitzky 1926; Anderson 1927; Avery 1930; Krauss 1933; Hayvard 1938; Akerberg 1943; Bradbury et al. 1956; MacLeod & Palmer 1966; Kowal & Rudnicka-Sternowa 1969; Rost 1973; Jones & Rost 1989; Rost et al. 1990; Ungurean & Costea 1994, 1997). According to our knowledge, micromorphology and anatomy of the caryopsis in *Echinochloa* have not been studied so far.

The purpose of this study is to evaluate the taxonomic usefulness of select floral characters in *Echinochloa*, namely, micro- and macrocharacters of the lemma and caryopsis, the caryopsis coat, and the size of starch grains. Furthermore, the nomenclature, the taxa limits and the interspecific relationships in *Echinochloa* are also discussed.

MATERIAL AND METHODS

Samples were collected and identified from populations in Spain and Romania.

The accessions from Spain were collected and identified by Professor José Luis Carretero from Polytechnic University Valencia, Spain (Table 1). The samples from Romania were collected and identified by the first author (Table 1). Mature spikelets were collected from the median region of the panicles as the spikelets from the upper parts of the inflorescence tend to be smaller. Micromorphological characteristics were assessed on 20 specimens in each population. Voucher specimens for all the taxa are preserved in the VALA, BUAG and BUC Herbaria collections.

Micromorphology of sterile lemmas and caryopses.—Ten mature caryopses for each specimen were examined. Only the adaxial (ventral) face of sterile lemmas and caryopses was observed. Sterile lemmas and caryopses were mounted on aluminium stubs with Avery's spot-o-glue and then coated with 20 nm of gold using Bio-Rad Sputter-Coatter SC-500. Samples were examined with 0° tilt at 5–15 KV on a Hitachi S-4100 Scanning Electron Microscope.

Structure of the caryopsis coat.—Mature caryopses with the glumes and bracts removed were soaked in warm water for 1 hour. Afterwards, they were fixed in FAA (90 ml 95% ethanol, 5 ml formalin and 5 ml glacial acetic acid) for 48 h. Caryopses were transferred to 70% ethanol, dehydrated in tertiary butyl alcohol (TBA), and embedded in Tissuemat. Ten mature caryopses for each specimen were serially sectioned to 5–10 µm, stained with safranin and fast green, mounted in Canada balsam, and examined with standard brightfield optics and with polarized light. A small number of caryopses belonging to each accession were soaked, fixed, embedded and sectioned without removing the glumes and bracts. The anatomy drawings were made using a Reichart camera lucida. The lengths of the largest fifty starch grains located in the mealy endosperm from each caryopsis, from each accession were measured as well.

SPIKELETS AND LEMMATAL MICROMORPHOLOGY

Depending on the environmental conditions, an *Echinochloa* spp. plant can produce 1500–22000 spikelets distributed on 9–25 panicle bearing culms. The spikelets have 2 flowers; the lower floret is sterile consisting only of lemma and palea. Sometimes the lower floret is staminate (especially in *E. colona*). The sterile lemma may be awned; but this character is relatively insignificant. The spikelets of *E. colona* are unawned, those of *E. oryzoides* are always awned, and those of the other species may be awned or not. An important character, emphasised by all authors, is the size of the spikelets. The lower glume is about 1/2 the length of the spikelets in *E. colona*; 1/2–3/4 in *E. crus-galli*, *E. oryzoides* and *E. hispidula*, and 1/2–3/5 in *E. oryzicola*. The lemma (in the species examined) is becoming indurated and difficult to remove. Micromorphological characters of the lemma for *Echinochloa* include: short cells (silica cells), long cells, bicellular microhairs, papillae and microhairs. Stomata may occasionally occur in all species. Cork cells were not observed on the *Echinochloa* sterile lemmas. Silica bodies are

TABLE 1. Description of sample populations.

Species	Source	Accesions
Echinochloa colona	Spain (VALA[a])	c1, c2, c3
	Romania (BUAG[b], BUC[c])	c11, c12
Echinochloa crus-galli	Spain (VALA)	cs501, cs606, cs825, cs820
	Romania (BUAG, BUC)	cs21, cs22, cs23
Echinochloa hispidula	Spain (VALA)	h802, h803, h805, h811.
Echinochloa oryzoides	Spain (VALA)	os808, os819, os909
	Romania (BUAG)	os31, os35, os40
Echinochloa oryzicola	Spain (VALA)	oa806, oa909
	Romania (BUAG)	oa64, oa69, oa70, oa71

a -Department of Botany, Polytechnic Institute Valencia, Spain.
b–Department of Botany, University of Agronomical Sciences Bucharest, Romania
c–Botanical Garden, University of Bucharest, Romania.

restricted to the intercostal regions. They can be cross-shaped or dumbbell-shaped. Within each category, 2 types can be further recognised.

Cross-shaped type (ratio length:width = 1:1).

C1. Silica bodies with the two endings deeply divided (Fig. 1e).

C2. Endings only slightly bilobed (Fig. 2b).

Dumbbell-shaped type (ratio length:width = 1:2).

D1. The two endings rounded (Fig. 1 a, f).

D2. The two endings emarginated or bilobed (Fig. 1d).

Even if one or two types of silica bodies predominate in one species, one sterile lemma may often contain sporadically the other types as well.

Long cells are easily recognizable by their length and their sinuous margins. Long cells are associated with papillae at their distal ends, especially near the apex of lemmas. Bicellular hairs, 30–60 µm long, are present in all species and belong to the *panicoid type* (Tateoka et al. 1959; Amarasinghe & Watson 1988; Watson & Dallwitz 1992–onwards). All the trichomes observed in *Echinochloa* (bicellular microhairs excepted) are more or less macroscopic. If shorter, they are only an earlier stage in the development of macrohairs. They tend to increase in frequency and length toward the distal parts of the lemmas. The marginal veins usually have the longest hairs. They are somewhat shorter or even missing from the median and lateral veins. Macrohairs are present in the intercostal regions but they are usually shorter compared to those of the marginal veins. In *E. oryzicola*, sterile lemmas often appear glabrous in the intercostal regions. The macrohairs are rigid, pointed and oriented toward the apex of the lemma.

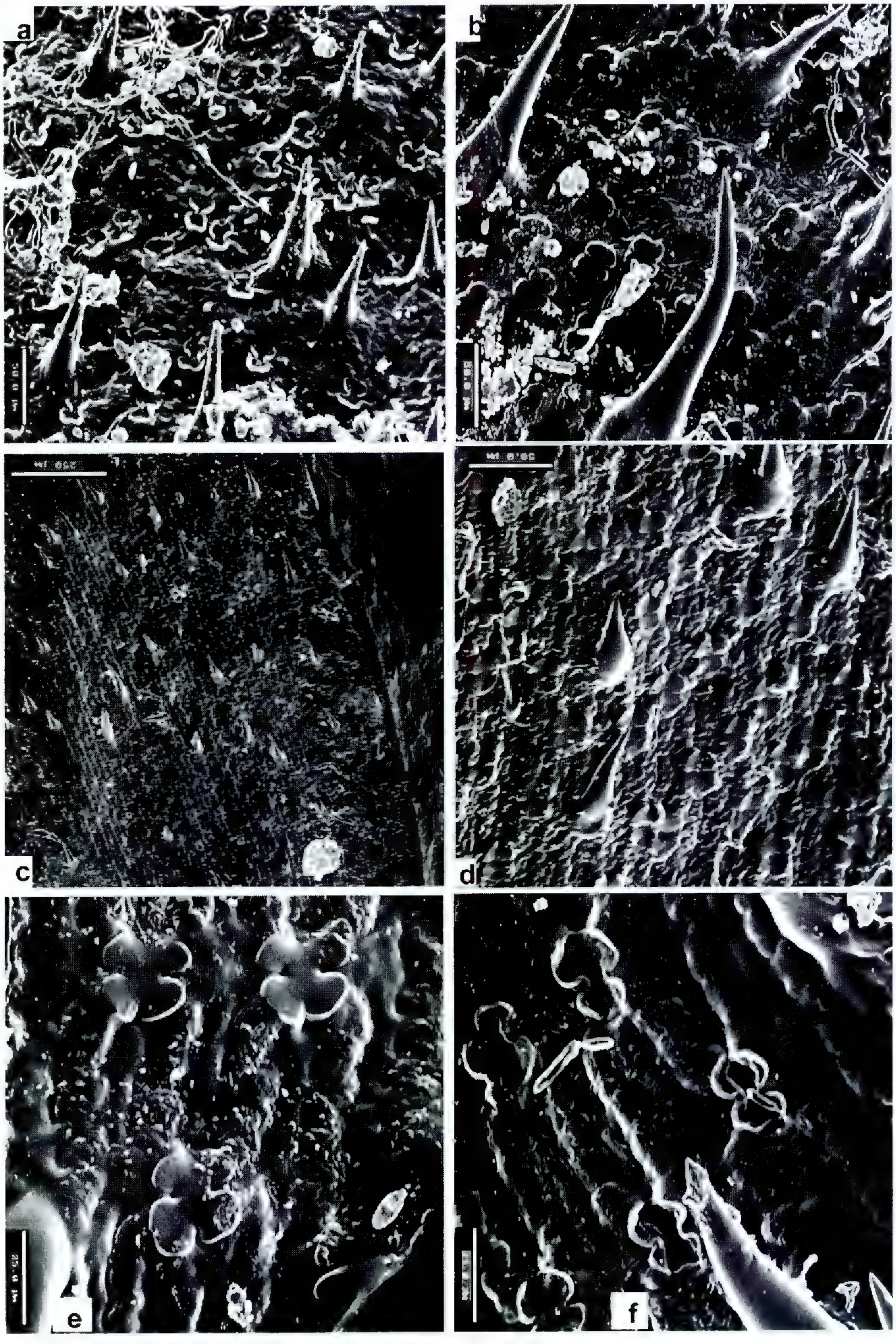


FIG. 1. Micromorphology of lemma. General view. **a.** *Echinochloa oryzoides* (scale bar 50 μm, **b.** *E. hispidula* (scale bar 50 μm), **c–d.** *E. oryzicola* (scale bar 250 μm and 50 μm); silica bodies, **e.** *E. oryzicola* (scale bar 25 μm), **f.** *E. hispidula* (scale bar 25 μm)

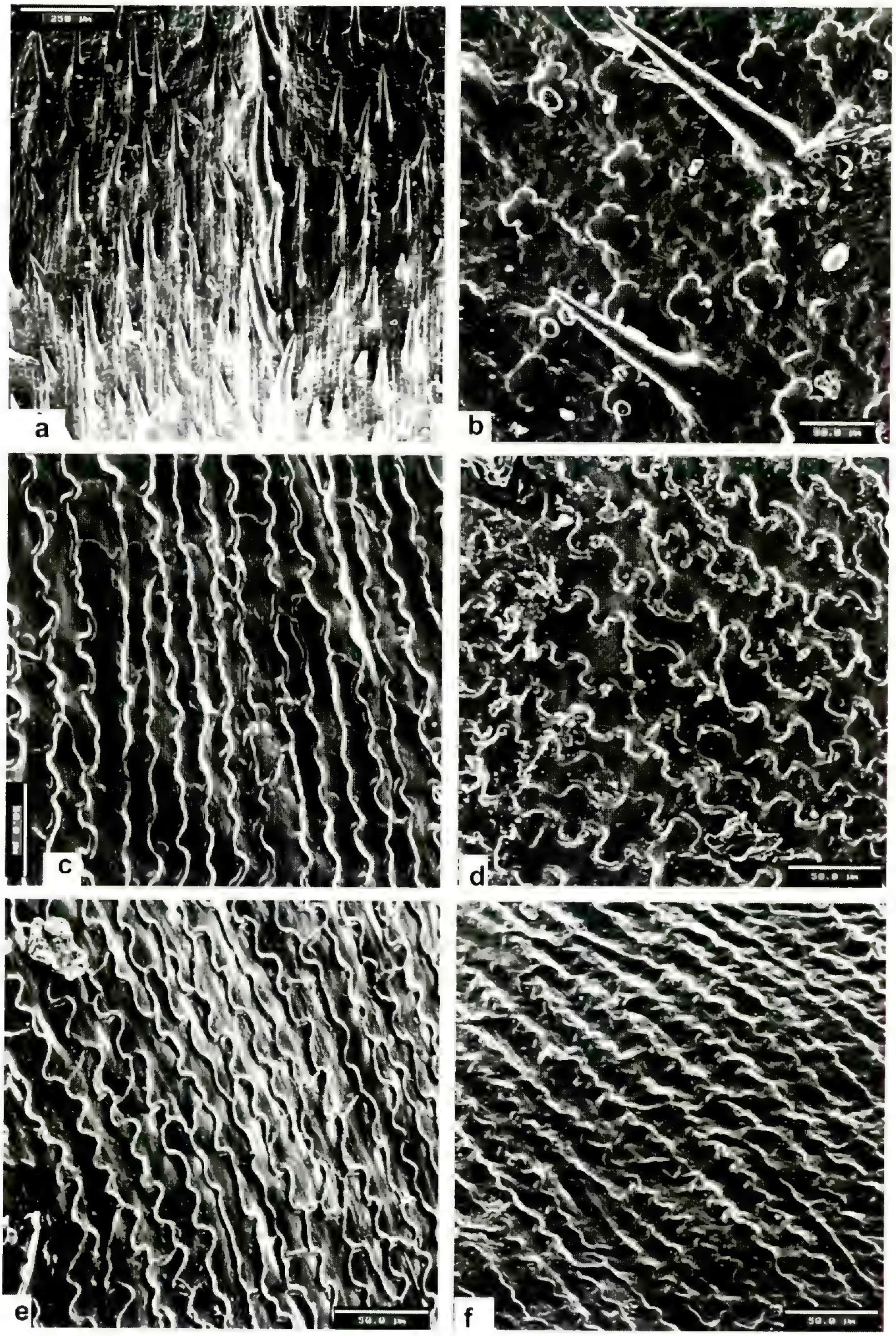


FIG 2. Micromorphology of lemma and caryopsis: **a.** general view of lemma in *Echinochloa crus-galli* (scale bar 250 μm), **b.** silica bodies in *E. crus-galli* (scale bar 50 μm). **c–f** Micromorphology of caryopsis: **c.** *E. oryzoides*, **d.** *E. crus-galli*, **e.** *E. hispidula*, **f.** *E. oryzicola* (scale bar 50 μm).

CARYOPSIS

Morphology of caryopsis (Fig. 3, a–e). Caryopsis is the dry, monospermous, indehiscent fruit of grasses in which the layers of pericarp are fused with the seed coat. The adnation between the pericarp and the seed coat starts in the placento-chalazal region and extends toward the rest of the caryopsis (Izaguire de Artucio & Laguardia 1987).

The size of caryopsis varies proportionally with the size of the spikelet and therefore is also an important differential character. The caryopsis is round, ellipsoid to ovate, with the ventral (adaxial) face rounded and the dorsal face (abaxial) more or less flat. The ventral face shows the axis of the embryo. The embryo is large, about 0.5 times the caryopsis length in *E. colona*; almost as long as the caryopsis in *E. oryzicola* and 0.6–0.7 times the caryopsis length in the other examined species. The scutellar region is visible around the embryo axis. The dorsal face features the basal pointed coleorhiza, which is also encircled by a rounded scutellar region. The hilum may or may not project on the outline of the caryopsis. When plants shed their spikelets, they land with the convex face down, in a position that brings the embryo in the most favourable position for germination. The glumes and sterile lemma then absorb the water necessary for germination. When they land in water, the spikelets float until imbibition is completed after which they sink and fall to the bottom of the water (Costea, unpublished). The mature caryopsis coat is shiny and whitish, yellowish or brown. The scutellar region prolonged around the embryo (on the convex, ventral face), is smooth or wrinkled, and may have black spots (*E. oryzicola*).

Micromorphology of caryopsis (Fig. 2, c–f) is not similar in the *Echinochloa* species examined. The epicarp cells are elongated ranging from 60–120 µm in length and 10–20 µm in width. The periclinal walls are flat, except for *E. oryzicola* which has concave periclinal walls (Fig. 2f). The anticlinal walls are protuberant and undulated with the amplitude, the width at the base and the shape of the undulations having diagnostic value. For example, in *E. crus-galli* (Fig. 2d) the anticlinal walls are Ω-undulated (undulations rounded, wider toward the apex and narrower at the base), in *E. orzyoides* and *E. hispidula* they are S-undulated, (Fig. 2c and e) and in *E. oryzicola* they are Z-undulated (Fig. 2f).

Anatomy of the caryopsis coat (Fig. 4, a–c) in the examined species is similar. The differences observed are minute and quantitative. The caryopsis coat consists of adnate layers of pericarp, seed coat and nucellus that surround the endosperm and embryonic axis. If the lemma is not removed, cross-sections reveal its connivence with the caryopsis. The structure of the lemma resembles the structure of the leaf. A homogenous mesophyll consisting of 2–4 cell layers can be observed between the 2 epidermis. During the early stages of development the mesophyll cells contain chloroplasts. These cells are larger than the epidermis cells, with thickened, sclerified cell walls at maturity (Fig 4, 1–c).

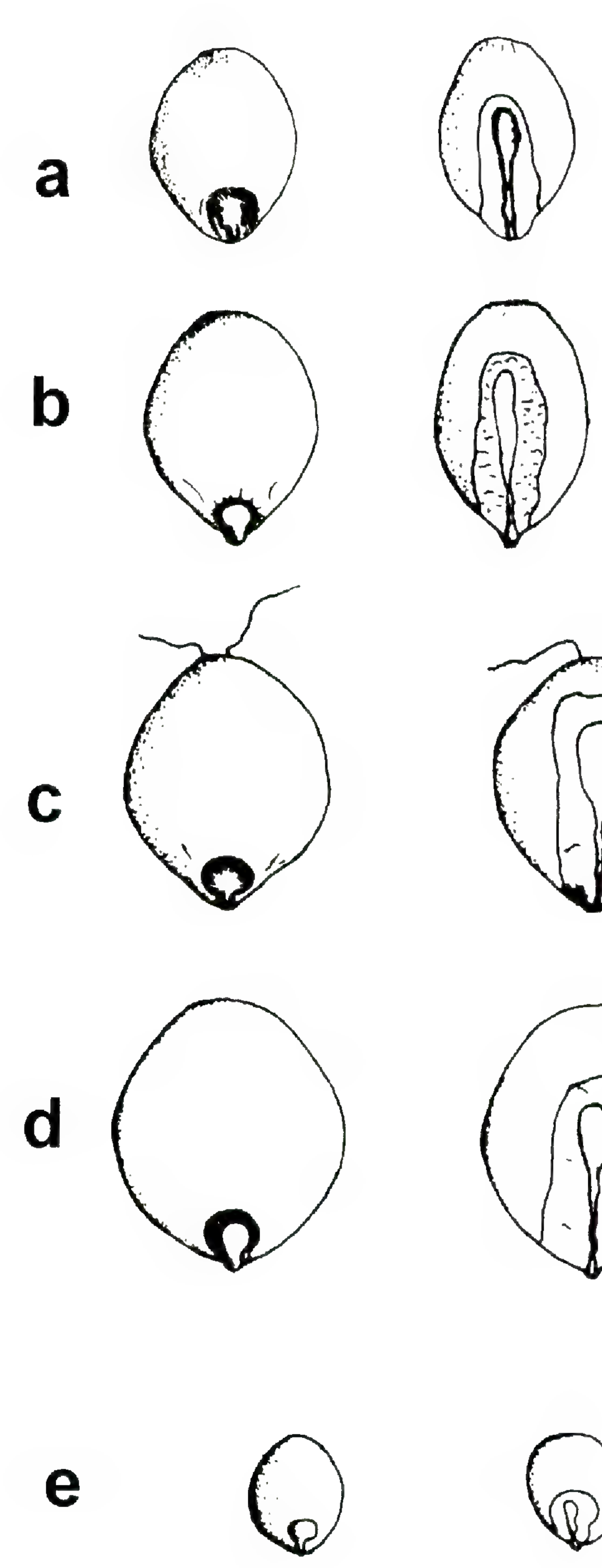


FIG 3. Morphology of caryopsis. **a.** *Echinochloa crus-galli*, **b.** *E. hispidula*, **c.** *E. oryzicola*, **d.** *E. oryzoides*, **e.** *E. colona*. Scale bar 1 mm.

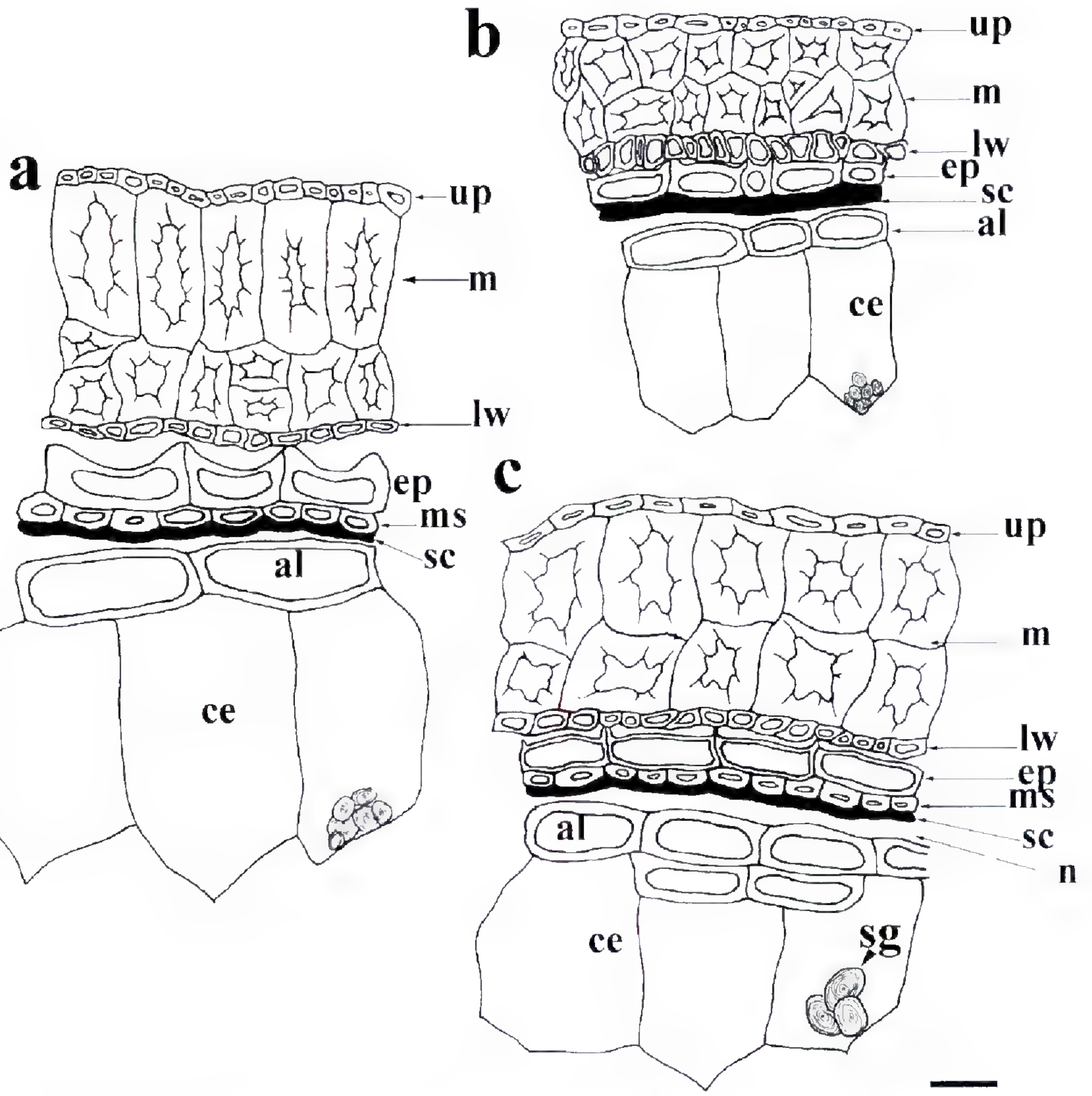


FIG. 4. Anatomy of caryopsis. **a.** *Echinochloa oryzicola*, **b.** *E. crus-galli*, **c.** *E. oryzoides*. **up**—upper epidermis of lemma, **m**-mesophyll of lemma, **lw**-lower epidermis of lemma, **ep**-epicarp, **ms**-mesocarp, **sc**-seed coat, al-alleurone layer, **ce**-central endosperm, **sg**-starch grains. Scale bar 10 μm.

The veins in young lemmas resemble the tertiary veins of the leaves. The caryopsis coat is thin (7–15 μm thick), with a simple structure. It consists of only 2–3 cell layers. The one-layered epicarp is the most representative component of the pericarp. The epicarp cells have thickened walls. The mesocarp is also single-layered with smaller and often crushed cells. At caryopsis maturity the endocarp is usually no longer visible. In younger caryopses it consists of long thin-walled cells ("tube-cells"), parallel to the epicarp cells. The seed coat is fused with the pericarp and it is not structured, visible only as brown line. The nucellus persists as a thin remnant. A single layered alleurone is continuous around the entire endosperm. The alleurone layer can be locally 2-layered in *E. oryzoides* (Fig. 4c). The central endosperm consists of large, irregularly shaped cells that contain simple starch grains. The central endosperm does not have a homogenous

appearance. Around the embryo the endosperm is "mealy" and soft while in the rest of the caryopsis is hard and glassy. In most of the species examined, the glassy endosperm predominates. However, in *E. oryzoides* the mealy endosperm is equaly or better developed than the glassy endosperm. The mealy endosperm contains rounded, isolated starch grains; only rarely they are aggregated (but not compound) in small groups of 2–4 granules. The hard endosperm has polygonal (rarely round) starch grains, closely packed together. This last type corresponds to the *Panicum* type described by Tateoka (1962). The average size of the starch grains is significant and it varies between 5.5 µm and 10.5 µm depending on the species. The embryo has a scutellar tail, without an epiblast.

SPECIES DESCRIPTION AND NOMENCLATURE

Nomenclature.—Most of the nomenclatural problems of *E. oryzicola* are related to the binomial *Panicum phyllopogon* on which *Echinochloa phyllopogon* (Stapf) Stapf ex Koss. is based. Stapf's diagnosis of *Panicum phyllopogon* addresses only the vegetative features of the plants, particularly the presence of hair tufts in the collar region of the leaves. For a long time this feature was erroneously considered to be an exclusive characteristic of only one species—*E. phyllopogon*, thus generating extensive nomenclatural confusion. The individuals of *Echinochloa oryzicola*—a more recent name—are constantly showing this vegetative characteristic. Consequently *E. oryzicola* has almost generally been considered a synonym of *E. phyllopogon* (Pirola 1965; Morariu 1972; Kerguélen 1975, 1993, 2002; Czerepanov 1981; Michael 1983; Chirilă 1984; Ciocarlan 2000). Kossenko (1940) further contributed to this confusion when he subordinated *E. oryzicola* as a subspecies of *E. phyllopogon* (1940). Other authors erroneously considered *E. oryzicola* to be a synonym of *E. hispidula* (Ohwi 1962; Gould et al. 1972) or even of *E. oryzoides* (Clayton 1980).

Stapf's collections of *Panicum phyllopogon* at Kew comprise both vegetative and fertile specimens. Tufts of hairs are obvious in most of the vegetative specimens and in several plants bearing inflorescences. Carretero (1981) noted that tufts of hair might also occur in the leaf collar of *E. hispidula* (1981). After examined Stapf's collection, Carretero (1981) synonymized *E. phyllopogon* with *E. hispidula*. Michael initially regarded Stapf's collection (1975 in herb, 1983) as a mixture of *E. phyllopogon* (the plants showing the vegetative characteristics) and *E. oryzoides*. Later, after examining populations from Spain, Italy and France he observed that individuals of *E. oryzoides* may also have leaves with hair tufts in the collar region and accordingly he synonymized *E. phyllopogon* with *E. oryzoides*. The author selected as a lectotype for *Panicum phyllopogon* the one sheet in which the inflorescence and tufts of hairs are evident on the same specimen (1985, note in the Kew Herbarium on the specimen selected as a lectotye, collected by Jacometti from "Novarra, in rice fields"). We support

Michael's view in that *E. phyllopogon* may be a synonym of *E. oryzoides* and that Stapf's collection is a mixture of *E. oryzicola* and *E. oryzoides* (= *E. phyllopogon*).

Many recent studies on the biology, ecology, herbicide resistance and physiology have been also using the binomial "*Echinochloa phyllopogon*" referring probably to *E. oryzicola* (Fox & Kennedy 1994; Fox et al. 1995; Mujer et al. 1995; Gibson et al. 1999; Fischer et al. 2000; Fischer et al. 2000).

Identification key.—The following key is modified from Carretero (1981) and Michael (1983).

In order to improve chances of correctly identifying the species, a range of individuals from the same population and a range of spikelets and caryopses belonging to the same plant should be collected and examined. Spikelets length measurements do not include the awns. Caryopsis measurements refer to dry caryopses. Starch grains should be observed in the mealy endosperm (around the embryo).

1. Spikelets 2–3 mm long, regularly arranged on the racemes. Caryopses whitish, 0.7–1.2 mm long with the embryo 0.4–0.5 of the caryopsis length ____ **E. colona**
1. Spikelets larger, irregularly arranged on the racemes. Caryopses larger, light-yellow or in different shades of brown, with the embryo 0.6–0.9 of the caryopsis length ____ **2**
   2. Spikelets 3.9–5 mm long; caryopses 2–3 mm long; starch grains 7–10 µm in diameter ____ **3**
   2. Spikelets 2.8–3.7 mm long; caryopses 1.4–1.8 mm long; starch grains 5–5.6 µm in diameter ____ **4**
      3. Coleoptyle red-purplish. Leaves often with a tuft of brown hairs in the collar region. Lower glume 1/2–3/5 the length of the spikelets, with the 3 veins visible only at the base. Sterile lemma often glabrous and shiny, rarely with stiff macrohairs, up to 0.8 mm. Caryopses brownish, 2–2.4 mm long, with the embryo 0.9 of the caryopsis length, and the glassy endosperm equal or more developed than the mealy endosperm ____ **E. oryzicola**
      3. Coleoptyle green. Leaves only rarely with a tuft of hairs in the collar region of the leaves. Lower glume 1/2–1/3 the length of the spikelets, with the 3 veins visible along their entire length. Sterile lemma never glabrous and shiny, provided with dense, stiff hairs up to 1mm long. Caryopsis light-yellow, 2.2–2.8 mm long, with the embryo 0.6–0.7 of the caryopsis length and the mealy endosperm more developed than the glassy endosperm ____ **E. oryzoides**
         4. Weeds of rice fields, occasionally with a tuft of hairs in the collar region of the leaves. The panicle is not pyramidal with branches often whorled. Spikelets ovate-elliptical, 3.3–3.8 mm long. Caryopsis 2–2.2 mm long with the scutellar zone transversely wrinkled ____ **E. hispidula**
         4. Weeds not obligate of rice, but sometimes occurring in rice fields especially on the margins of the ponds. Leaves never with hairs in the collar of the leaves. Panicle pyramidal with the branches never obviously whorled. Spikelets ovate, 2.8–3.4 mm. Caryopsis ovate, 1.4–1.9 mm, with the scutellar zone smooth ____ **E. crus-galli**

1. Echinochloa colona (L.) Link, Hort. Berol. 2:209. 1833. TYPE: "JAMAICA:" Antilles, *Browne* (LINN). *Panicum colonum* L., Syst. Nat., ed. 10, 2:870. 1759. *Echinochloa crus-galli* (L.) Beauv. subsp. *colona* (L.) Honda, Bot. Mag. (Tokyo), 37:22.1923.

= *Panicum zonale* Guss., Fl. Sic. Prod. 1:62. 1827.
= *Echinochloa verticillata* Berhaut, Bull. Soc.Bot. Fr., 1953:11. 1954.

There is still disagreement over how to write the specific epithet, as various authors have used either "*colonum*" or "*colona*" to designate the species The specific epithet is most likely derived from the medieval Latin adjective "*colonus-a-um*," in which case "*Echinochloa colona*" is the correct spelling. Another hypothesis (Carretero 1981) is that the specific epithet results from the contraction of the word "*colonorum*," the plural genitive of "*colonus-i*," although we believe this to be less probable.

Echinochloa colona is the most easily recognised species. It is annual, often rooting at the lower nodes. The leaves may have purplish transversal bands. The inflorescence is usually erect, with short branches (the lower ones are shorter to equalling 3 cm long). The spikelets are regularly arranged on the racemes. Often the lower floret of the spikelets is staminate. The lower lemma is awnless, not exceeding 2 mm long. The spikelets are ovate, 2–3 × 1.2–1.8 mm. The lower glume is 3-veined, about 1/2 as long as the spikelet. The upper glume is 5-veined. The sterile lemma is 7-veined. The median vein may or may not have macrohairs. Longest macrohairs, 1 mm long. Lateral veins are only distally conspicuous. The silica bodies are of type D2. The stigmas are dark-red.

The caryopsis (Fig. 3e) is round to almost so, whitish and translucent, (0.7–) 0.9–1.2 × 0.7–1.1 mm. The embryo is 0.4–0.5 of the caryopsis length. The epicarp cells are 40–65 × 8–12 μm. The periclinal walls are flat. The anticlinal walls are moderately thick (2.1–2.7 μm), undulated; the amplitude of the undulations is 5–10 μm, and their width is 6–12 μm. The undulations are Ω-shaped or S-shaped. Starch grains, 5.6 (± 0.24) μm long. The chromosome number is 2n = 6x = 54 (Carretero 1981; Yabuno 1985; Koul & Gohil 1991; Devesa et al. 1991).

This species is a widespread weed in rice fields in tropical and subtropical areas of the globe. In Europe it has been recorded in the warmest countries (Spain, Portugal, Italy, France, Turkey, Greece), where it grows as a ruderal or segetal weed in irrigated crops (and sometimes also in rice). It seems to be expanding towards typical temperate countries where it usually grows as a ruderal. As an example, we are recording the occurrence of this species for the first time in Romania where we have encountered it since 1996 growing as a ruderal in the Railroad Station in Bucharest.

2. Echinochloa oryzicola (Vasing.) Vasing. in Komarov, Fl. U.R.S.S. 2:33. 1934. TYPE: "Oriente Extremo inter segetes *Oryzae sativae* L." *Panicum oryzicola* Vasing., Bull. Appl. Bot. Pl.-Breed. (Leningrad) 25(4).125. 1931. *Echinochloa phyllopogon* (Stapf) Koss. subsp. *oryzicola* (Vasing.) Koss., Not. Syst. Herb. Acad. U.R.S.S. 8(12):210. 1940. *Echinochloa crus-galli* (L.) Beauv. var. *oryzicola* (Vasing.) Ohwi, Acta Phytotax. Geobot. 11:38. 1942.

= *Echinochloa phyllopogon* auct., non Stapf

Annuals; the European populations with a tuft of brownish hairs in the collar

region of the leaves. The hairs are obvious from the two or four leaf stage. Yabuno (1962, 1981) studying Asian populations found that different forms – notably his C and F forms – do not always exhibit the tuft of hairs in the collar region of the leaves. The inflorescence is normally erect and spreading but occasionally can be horizontal or pendent and may be green to red coloured. Spikelets are ovate-elliptical, awned (awn not exceeding 2 cm in length) or not, measuring 3.9–4.8(–5) × 2.2–2.4 mm. The spikelets persist in the panicle longer than in *E. oryzoides*. The lower glume is about 1/2–3/5 the length of the spikelet, with 3 veins only partially visible. The upper glume is 5–7 veined. The sterile lemma is 4–5 veined. The median veins may or may not have short hairs (0.5–0.6 mm); the laterals veins are conspicuous only toward the apex. The longest macrohairs are up to 0.8 µm long. The sterile lemma can be: a) glabrous and shiny, convex—with the lateral veins visible only along their distal part. In the intercostal regions the macrohairs are rare, short, 0.1–0.4 mm, with a swollen base (Fig. 1, c and d) (C-form of Yabuno 1962, 1981). This is the most common type encountered in Europe. b) more or less flat and coarse, with dense long macrohairs, up to 0.8 mm in the intercostal regions (F-form of Yabuno 1962, 1981). The silica bodies may be type C2 (Fig. 1e) or D2 (Fig. 1d). The stigmas are red. The caryopsis is ellipsoidal to almost round measuring 2–2.4 × 1.8–2.1 mm (Fig. 3c). The embryo is 0.75–0.9 of the caryopsis length. Often the stigmas are persistent. The hilum is prominently visible on the outline of the caryopsis. The colour is brownish-red, brownish-green or brownish-grey. The scutellar zone is irregularly wrinkled often with black spots. The epicarp cells are 100–120 × 15 µm. The periclinal walls are concave (Fig. 4a). The anticlinal walls are moderately thick (2.6–3.2 µm) and undulated; the amplitude of the undulations is 8–10 µm, and their width is 6–7 µm (Fig. 2f). The undulations are Z-shaped (acute and narrow toward the apex) (Fig. 2f). The glassy endosperm predominates or it is as developed as the mealy endosperm. Starch grains are 7.14 (± 0.51) µm in length. The chromosome number is 2n = 4x = 36 (Carretero 1981; Yabuno 1985, 1996).

This species originated in China and SE Asia and is now a weed of rice in Europe, Asia, North and South America. The biology and ecology of a cultivated form of *E. oryzicola* has been recently described by Hirosue et al. (2000).

3. Echinochloa crus-galli (L.) Beauv., Ess. Agrost.:53, 161, tab. 11, fig. 2. 1812. TYPE: "Europae, Virginiae cultis" (LINN). *Panicum crus-galli* L., Sp. Pl., ed. 1:56. 1753. *Milium crus-galli* (L.) Moench, Meth:202. 1794.

The herbarium sheet number 80.18 (LINN) contains a specimen collected by Kalm in Canada, annotated by Linnaeus himself as *Panicum crus-galli*. Several authors (Hitchcock 1920; Baum 1967; Carretero 1981; Michael 1983) observed that this specimen does not belong to *E. crus-galli*. The same situation occurs with the other two sheets labelled *Panicum crus-galli* (80.19 and 80.20) by Linnaeus. According to Carretero, only the specimen 80.17 labelled by Linnaeus as *Panicum crus-corvis* corresponds to *E. crus-galli*. Ali (1968) and Gould et al. (1972) designated a neotype. Michael (1983) designated as a lectotype the specimen 1: 303

from Burser's Herbarium at the University of Uppsala [in order to retain the specific epithet, Baum suggested the same solution but he did not select a lectotype (1967)].

= *Panicum crus-corvi* L., Sp. Pl., ed. 2, 1:84. 1762.

Annuals with erect to spreading or decumbent stems, up to 120 cm. The panicle is often pyramidal with purplish nuances, erect, but sometimes nodding. The inflorescence branches are longer than 3 cm, patent or erect-patent, never obviously whorled. The lower branches are frequently twice branched. The spikelets are irregularly arranged on the racemes and the lower floret is rarely staminate. Spikelets are ovate to broadly-ovate, 2.8–3.4 × 1.6–1.8 mm. The lemma of the lower floret is awnless or awned, the awn not exceeding 5 cm in length. The lower glume is 3-veined and about 1/2–1/3 the length of the spikelet. The upper glume is 5–7 veined. The sterile lemma is 7-veined. The lateral veins are visible along their entire length or only toward the apex. The longest macrohairs are about 1 mm long. The silica bodies belong to types C2 or D2 (Fig. 2b). The stigmas are white or red.

The caryopsis is ovate, 1.4–1.9 × 1.3–1.6 mm, brownish-red or brownish-grey in colour. The embryo is 0.6–0.7 of the caryopsis length (Fig. 3a). The epicarp cells are 60–80 × 10–15 µm. The periclinal walls are flat. The anticlinal walls are thick (2.6–3.2 µm) and undulated; the amplitude of the undulations is 8–10 µm, and their width is 6–7 µm. The undulations are Ω-shaped (Fig. 2d). The glassy endosperm predominates. The starch grains are 5.9 µm (± 0.37) in length. The chromosome number is 2n = 6x = 54 (Carretero 1981).

This species is probably the most widespread of the genus, being a common and noxious weed all over the world, especially in irrigated crops. It is less limited to warm climate compared to *E. colona* and *E. hispidula*. In rice it usually grows on the pond margins, but it may also penetrate the interior of the rice fields.

4. Echinochloa hispidula (Retz.) Nees ex Royle, Ill. Bot. Himal. 11:416, 420. 1840.

TYPE: "India Orientali," König (LD). *Panicum hispidulum* Retz., Obs. Bot. 5:18. 1789. *Echinochloa crus-galli* (L.) Beauv. var. *hispidula* (Retz.) Honda, Bot Mag. (Tokyo) 37:122. 1923. *Echinochloa crus-galli* (L.) Beauv. subsp. *hispidula* (Retz.) Honda, J. Fac. Sci. Tokio Univ., Bot. 3:267. 1930.

= *Echinochloa phylloryzoides* Novelli, Giorn. Risic. 2:306 (1912).

= *Echinochloa erecta* (Pollacci) Pignatti, Arch. Bot. (Italy) 31, ser. III, 15(1):2. 1955. *Echinochloa crus-galli* (L.) Beauv subsp. *erecta* (Pollaci) Ciferri & Giacomini Nomencl. Fl. Ital. 1:20. 1950.

Annuals which may occasionally have tufts of hairs in the collar region of the leaves. The panicle is rarely pyramidal, erect to pendent, green or with purplish nuances. The branches are whorled and more or less erect, except for the lowermost ones. Spikelets are ovate-elliptical of 3.3–3.6(–3.8) × 1.7–1.8 (–2) mm. The lower glume is 3-veined, about 1/2–1/3 of the spikelet length, and the upper glume is 5–7 veined. The sterile lemma is 7-veined resembling *E. crus-galli*. The longest macrohairs are about 0.8 mm long (Fig. 1b). The silica bodies are very

variable, depending on the population – C1 (h802) (Fig. 1b), C1 and D1 (h803, h805), C2 and D2 (h805). The stigmas are white but may occasionally be red.

The caryopsis is larger that of *E. crus-galli*, ovoid to oblong, 2–2.2 × 1.5–1.8 mm and brownish-red or brownish-grey in colour (Fig. 3b). The embryo is 0.6–0.7 the caryopsis length, and the scutellar zone is transversally wrinkled (Fig. 3b). The hilum is projecting on the outline of the caryopsis. The epicarp cells are 65–90 × 10–15 µm. The periclinal walls are flat. The anticlinal walls are thick (2.6–3.2 µm) and S-undulated; the amplitude of the undulations is 8–10 µm and their width is 6–6.5 µm (Fig. 2e). The glassy endosperm predominates. The starch grains are in average 6.3 (± 0.47) µm in length. The chromosome numbers reported are: 2n = 6x = 54 (Devesa et al. 1991) or 2n = 36 (Carretero 1981; Feng & Zhang 1993).

This taxon probably originated in the SE Asia. It is widespread in tropical and temperate areas of Asia, Africa, America and Australia. In Europe it grows only in the warmest regions (Spain, Italy, Portugal and France) as a weed of rice fields.

5. Echinochloa oryzoides (Arduino) Fritsch, Verh. Zool.-Bot. Ges. Wien 41: 742. 1891. TYPE: "Semina hujus Panici inventa a me fuere inter Oryzam" *Panicum oryzoides* Arduino, Animadv. Bot. Spec. Alt. 16, tab. 5. 1764. *Panicum crus-galli* L. var. *oryzoides* (Arduino) Fiori, Nuov. Fl. Anal. Ital. 1:79. 1923.

= *Echinochloa crus-galli* (L.) Beauv. subsp. *oryzoides* Bolos & Masclans, Collect. Bot. 4:420. 1955.
= *Panicum hostii* Bieb., Fl. Taur. Cauc. 3:57. 1819. *Echinochloa crus-galli* (L.) Beauv. subsp. *hostii* (M. Bieb.) K. Richter, Pl. Eur. 1:26. 1890.
= *Panicum phyllopogon* Stapf, Hook, Ic. Plant., ser. 4, plate 2698. 1901. *Echinochloa phyllopogon* (Stapf) Stapf. ex Koss., Not. Syst. Herb. Acad. U.R.S.S. 8 (12):208. 1940.
= *Echinochloa macrocarpa* Vasing. in Komarov, Fl. U.R.S.S. 2:739. 1934. *Echinochloa crus-galli* L. Beauv. var. *macrocarpa* (Vasing.) Morariu in Savulescu, Fl. Rom. 12:86. 1972.
= *Echinochloa coarctata* Koss., Not. Syst. Herb. Acad. U.R.S.S. 9(1):28. 1941.
= *Echinochloa commutata* Schultes in Roemer & Schultes, Syst. Veg., ed. 15, Mant. 2:267. 1824.

Annuals with erect to spreading or decumbent stems, up to 130 cm tall. The seedlings have a reddish coleoptyle. Tufts of hairs in the collar region may be infrequently present. The inflorescence is green, pendent and at maturity hanging almost horizontally, resembling rice in habit. The branches of the panicle are often adpressed to the main rachis. The spikelets are rather persistent, usually awned (awn up to 5 cm long), broadly-ovate to ovate and (3.6–)4.1–5 × 2.2–2.6 µm. The lower glume is about 1/2–1/3 the length of the spikelet, with 3 veins visible across their entire length. The upper glume has 5 veins also entirely visible. The sterile lemma is 7-veined, with the lateral veins usually visible along their entire course. The longest macrohairs are about 1 mm long (Fig. 1a). The silica bodies belong to the type D1 (Fig. 1a). The stigmas are red.

The caryopsis is ovate to almost round, 2.2–2.8 × 1.9–2.3 mm (Fig. 3d) and yellowish. The embryo is 0.6–0.7 the caryopsis length, with the scutellar region

zone smooth (Fig. 3d). The epicarp cells are 100–120 × 10–15 µm. The periclinal walls are flat. The anticlinal walls are moderately thick (2–2.6 µm) and weakly S-undulated (Fig. 2c). The amplitude of the undulations is 1–3 µm, and their width is 8–11 µm. The mealy endosperm predominates. The starch grains are 9.5 µm (± 0.58) in length. The chromosome numbers reported are: 2n = 36 (Carretero 1981) and 2n = 6x = 54 (Yabuno 1984; Feng & Zhang 1993).

The species is a common weed in rice occurring in many countries from Asia, Europe, North America, South America and Australia. It is probably one of the most widespread species after *E. crus-galli* and *E. colona*.

DISCUSSION

Characters

The genus *Echinochloa* does not have qualitative characters which clearly demarcate its species. A good example is the presence of hair tufts in the collar region of the leaves which has been considered an exclusive feature of *E. phyllopogon*. This assumption has subsequently caused a widespread nomenclatural and taxonomic confusion because as we have previously indicated, three species may show this feature (*E. oryzicola* commonly; *E. hispidula* and *E. oryzoides* rarely). Even the most significant qualitative character states overlap between species. When such characters are noted they are always accompanied by the words "often," "usually," "normally," etc. because exceptions are possible. The occurrence of a feature should be understood as a predilection and not as an exclusive characteristic.

Lemmatal micromorphology.—The long cells, microhairs and papillae are the same in all species examined. The pattern of papillae in *Echinochloa* species is similar to the pattern described in the fertile lemmas of some *Panicum* species (Clark & Gould 1975). The macrohairs are more or less similar in the examined taxa. Shorter hairs that could be described as prickles (Metcalfe 1960; Ellis 1979) were observed in all species. However, because these shorter hairs represent a developmental stage, only the macrohairs are recognised in this study as a distinct category (see Snow 1996, 1998 for considerations on homology and ontogeny of hairs in *Poaceae*). Variations in length, distribution and density of macrohairs are minute and there is considerable overlapping among species. The only exception is the short, rare macrohairs, with swollen bases from the intercostal regions of sterile lemmas in *E. oryzicola* (in the "form C" of Yabuno 1962, 1981). These hairs are constant in their morphology and can be considered intermediate to prickles (Metcalfe 1960; Ellis 1979). Silica bodies have previously been considered structures of taxonomic significance in *Poaceae* (Metcalfe 1960; Ellis 1979; Palmer & Tucker 1981; Evoli & Pirola 1971). In *Echinochloa*, silica bodies vary in shape even within a small area of the same lemma. However, in most species there is a tendency toward one or two types. *Echinochloa hispidula* was the most variable of all species examined in this

study. The silica bodies varied from population to population, with all the different types observed. The previous epidermis studies conducted on leaves (Sanchez 1968; Pirola & Evoli 1971; Carretero 1981; Jin et al. 1986) are rather contradictory but they all showed an even greater variation of this character. Even if the results obtained in this study revealed some differences between species (*E. hispidula* excepted), the shape characteristics of the silica bodies should be regarded with caution. More populations need to be examined before a final conclusion is reached. The same cautionary approach towards the taxonomic utility of the silica body shape is suggested by other studies conducted on *Zizania* (Terell & Wergin 1981), *Oryza* (Whang & Kim 1994) and *Leptochloa* (Snow 1996). Ball et al. (1999) showed that silica phytoliths examined individually are taxonomically irrelevant. The authors instead used detailed morphometrics, computer-assisted imagery and statistical analysis to develop a classification key of several *Triticum* and *Hordeum* species. The presence or absence of silica bodies in lemmas can prove useful at higher ranks (genera and above) since their presence is probably symplesiomorphic (Snow 1996).

Caryopsis.—The simple morphology of the caryopsis provides good characters for species identification. The size of caryopsis is important and correlated with the size of the spikelets. The other characters overlap between species but may be useful diagnostics is some cases, eg: caryopsis whitish, translucent (*E. colona*), yellowish (*E. oryzoides*); embryo 0.4–0.5 of the caryopsis length (*E. colona*) or 0.75–0.9 (*E. oryzicola*). Surprisingly, surface patterns of the caryopsis proved to be significant in the differentiation between almost all *Echinochloa* species. However, more populations should be examined before any definite conclusions can be reached.

The anatomy of the caryopsis is of minimal systematic value. The overall organization of the caryopsis coat resembles the structures described in *Setaria* (Rost 1973) or *Melica* (Rost and Izaguire de Artucio 1990). The structural simplicity of the pericarp can be a functional result of the indurated lemma that protects the caryopsis. In those grasses where no coalescence between the caryopsis and lemma occurs, or when the lemma is thin, the pericarp is more complex structurally (as for example in many *Triticoideae*—Netolitzky 1926; Avery 1930; Krauss 1930; Bradbury et al. 1956; Ungurean & Costea 1994). The anatomy of the sterile lemmas in *Echinochloa* species could be more important as a taxonomic character than the structure of the caryopsis coat. The structural features and surface pattern of the lemma indicate its ontogenetic connection with the leaves.

The average size of the starch grains examined in a large number of endosperm cells and caryopses is constant and significant among the species examined and therefore can be considered a diagnostic feature. This character is as significant in the taxonomy of the genus as other quantitatively important characters such as the size of spikelets, and size of caryopses.

Relationships between species

The individuality of *Echinochloa* species as treated in the present study is apparently reinforced by studies of their biology and ecology (Holm et al. 1977, 1997; Szilvássy 1976; Chirilă 1967; Carretero 1981; Yabuno 1983; Norris 1996; Honek & Martinova 1996). The appropriate understanding of *E. oryzicola* was delayed by nomenclature problems since this binomial has been almost generally considered a synonym of *E. phyllopogon* (Pirola 1965; Morariu 1972; Kerguélen 1975, 1993, 2002; Czerepanov 1981; Michael 1983; Chirilă 1984; Ciocarlan 2000). Apart from this nomenclatural confusion *E. oryzicola* is the second species easiest to differentiate (after *E. colona*) even using classic morphologic characters. It has the second largest (after *E. oryzoides*) spikelets, caryopses and starch grains; the micromorphology of the sterile lemma and caryopsis are quite peculiar as well.

Yet apart from *E. colona* and E. oryzicola, which are usually easily recognisable, the other 3 taxa comprise a difficult complex. *Echinochloa hispidula* is extremely variable and shares close affinities with both *E. oryzoides* and *E. crus-galli*. Several current treatments tend to view *E. hispidula* as a subspecies or as a variety of *E. crus-galli* (Michael 1983; Mateo Sanz 1990; Devesa 1991; Janzein 1993; Mateo Sanz & Crespo Villalba 1995; Kerguélen 1993, 2002; Asíns et al. 1999). However, Gonzales-Andres et al. (1996) studying the izoenzyme variation of these species, reached another conclusion: only 3 species—*E. colona*, *E. crus-galli* and *E. oryzicola*—were clearly defined. *Echinochloa hispidula* and *E. oryzoides* clustered together, and the variability between the populations of *E. hispidula* was higher than the variability between both taxa. Therefore, the authors suggested that the most appropriate classification would be *E. hispidula* as a subspecies of *E. oryzoides*. Asíns et al. (1999) studying the morphologic and isozyme patterns of variation of the same species, found only *E. colona* and *E. oryzicola* to be distinct from both morphologic and molecular point of view. Based on their morphology, the populations of *E. crus-galli*, *E. hispidula* and *E. oryzoides* congruently clustered together within each species. However, based on the isozyme variation, there was a considerable overlapping between species suggesting a high degree of genetic variation. Consequently, Asíns et al. (1999) advocated that *E. hispidula* and *E. oryzoides* as infraspecific taxa of *E. crus-galli* would be the most appropriate classification. We consider that in order to reach a final conclusion more populations worldwide should be analysed using combined molecular (such as RAPD, AFLP, ISSR and DNA fingerprints) and morphologic methods, and the data resolved in a cladistic approach involving all characters. The enormous variation observed makes the boundaries between these taxa rather uncertain and in order to avoid an arbitrary classification, we maintained each taxa at specific level. In *Echinochloa* the amplitude of morphologic variation can serve as a basis for taxa differen-

tiation. Each taxon has a distinct morphologic core and the variation—statistically understood—can serve to their delimitation.

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SEED AND FRUIT CHARACTERS IN SELECTED SPERMACOCEAE AND COMPARISON WITH HEDYOTIDEAE (RUBIACEAE)

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ABSTRACT

Seed and fruit morphology of ten species of five American genera of Spermacoceae (*Diodia*, *Ernodea*, *Mitracarpus*, *Richardia*, *Spermacoce*) are described, illustrated, and compared with that in the Hedyotideae. These data support the taxonomic recognition of two distinct tribes.

RESUMEN

La morfología de la semilla y del fruto de diez especies de cinco géneros americanos de Spermacoceae se describe, se ilustra, y se compara con la de Hedyotideae. Estos datos apoyan el reconocimiento taxonómico de dos tribus distintas.

INTRODUCTION

Seed morphology in *Houstonia* L. and related genera in the tribe Hedyotideae Cham. & Schltdl. ex DC. (Rubiaceae) has contributed valuable information, especially when combined with data from chromosome number and pollen structure (Terrell et al. 1986; Terrell 1996). More recent taxonomic studies have continued to emphasize the importance of seed data (Terrell 2001a, 2001b, 2001c).

This study investigates the morphology of the seeds and fruits in selected genera in the tribe Spermacoceae Bercht. & J. Presl. We contrast this information with previously acquired seed data for the Hedyotideae. The two tribes include some superficially similar genera and species (e.g. *Oldenlandia* L. and *Spermacoce* L.), but structure and development of their fruits and seeds are fundamentally different and deserve further study. The Hedyotideae have few to many small seeds per locule, nearly always in subglobose biloculate capsules. In contrast, the fruits of Spermacoceae have one large seed per locule and are generally more structurally complex and vary considerably among the genera. Bremer and Manen (2000) expanded the tribe Spermacoceae to include the Hedyotideae; however, our data from seed and fruit morphology in five genera do not appear to support this inclusion.

Verdcourt (1958) proposed a classification of the Rubiaceae in which he recognized three subfamilies. The Rubioideae, the largest subfamily, contained 17 tribes including the Hedyotideae and Spermacoceae. Bremekamp (1966)

modified Verdcourt's system and recognized eight subfamilies in the family and 19 tribes in the Rubioideae (including the Hedyotideae and Spermacoceae). Verdcourt (1976), still recognizing his original three subfamilies, reduced the number of tribes in the Rubioideae to 12 and maintained Hedyotideae and Spermacoceae. Robbrecht (1988, 1993) recognized four subfamilies and 19 tribes in subfamily Rubioideae. The latter included Hedyotideae and Spermacoceae.

MATERIALS AND METHODS

Scanning electron microscopy was employed in this study of seeds and fruits. The investigation was carried out at the Biology Department, University of South Florida, using a JEOL JSM-35 microscope operating at 15 kilovolts. Ten species in five genera were examined from herbarium material at the University of South Florida (USF) (Table 1). The species examined were those most readily available and representative of species native to tropical America, especially of the Caribbean basin. Tables 1 and 2 provide nomenclatural author's names.

RESULTS

The Spermacoceae is a pantropical tribe that may consist of as many as 19 genera and 450 species. Its generic delimitations are a matter of dispute. Eleven currently recognized genera native to the New World are summarized in Table 2. Morphological characters of the seeds and fruits of five genera of Spermacoceae native to the Americas are described as follows:

Diodia: Ovary 2(3–4)-locular; ovules solitary in each locule, attached to the middle of the septum. Fruit with 2(3–4) indehiscent mericarps, these fleshy or dry capsules. Seed enclosed within the hardened mericarp (accessible only by dissection), oblong, somewhat compressed, the dorsal surface convex, the ventral surface with a slightly sunken, central, longitudinal groove (see comments in Discussion), the testa finely reticulate (Fig. 1A–D).

Ernodea: Ovary 2-locular; ovules solitary in each locule, attached to the middle of the septum. Fruit fleshy, oblong, becoming hardened in drying, not easily separated into indehiscent mericarps (accessible only by dissection). Seeds oblong, somewhat compressed, the dorsal surface convex, the ventral surface with a slightly sunken, central, longitudinal groove, the testa finely reticulate (Fig. 3C,D)

Mitracarpus: Ovary 2(3–4)-locular, ovules solitary in each locule, attached near the middle of the septum. Fruit a thin-walled circumscissile capsule, the distal portion falling away with the calyx limb, the septum usually persistent. Seed oblong to globose, the dorsal surface convex, the ventral face divided into 4 distinct areas by an x-shaped groove, the testa finely reticulate (Fig. 3A,B).

Richardia: Ovary (2–)3–4(–6)-locular, ovules solitary in each locule, attached near the middle of the septum. Fruit dehiscing into dry mericarps, the ventral mericarp face with either a medial keel or narrow groove. Seed filling

Table 1. List of species and collections examined for this study.

Species	Source/Voucher Information
Diodia teres Walter	Florida. St. Johns Co.: *Hansen & Hansen 9844* (USF)
Diodia virginiana L.	Florida. Collier Co.: *Lakela 27450* (USF)
Ernodea littoralis Sw.	Florida. Monroe Co.: *Gann & Bradley 449* (USF)
Mitracarpus hirtus (L.) DC.	Florida. Lake Co.: *Daubenmire & Daubenmire s.n., 18 Oct 92* (USF)
Richardia brasiliensis Gomes	Florida. Hillsborough Co.: *Gregory 7* (USF)
Richardia humistrata (Cham. & Schltdl.) Schult. & Schult.f.	Florida. Escambia Co.: *Wilhelm & Burkhalter 7877 (USF)*
Richardia scabra L.	Florida. Hillsborough Co.: *Robinson s.n., 14 Jul 77* (USF)
Richardia tricocca (Torr. & A. Gray) Standl.	Mexico. Hidalgo: *Hernández M. & Vásquez 3466* (USF)
Spermacoce assurgens Ruiz & Pav.	Florida. Pinellas Co.: *Fleming 3862* (USF)
Spermacoce prostrata Aubl.	Florida. Collier Co.: *Lakela 31721* (USF)
Spermacoce tetraquetra A. Rich.	Florida. Miami-Dade Co.: *Bradley 1999* (USF)
Spermacoce verticillata L.	Florida. Dade Co.: *Avery 589a* (USF)

TABLE 2. Eleven currently recognized genera of Spermacoceae native to the Americas, the estimated number of species, native distribution, and reference to a recent taxonomic treatment.

Crusea Cham. & Schltdl. 13 spp.	southwestern U.S., Mexico; Anderson 1972.
Diodia L. 5 spp.	North America, Mexico, Central America, West Indies, and South America; Bacigalupo & Cabral 1999.
Emmeorhiza Pohl ex Endl. 1 sp.	Brazil.
Ernodea Sw. 4 spp.	Florida, West Indies, Belize, Honduras, and Guatemala; Negron-Ortiz and Hickey 1997.
Galianthe Griseb. ca. 50 spp.	Central America and South America; Cabral 1991.
Mitracarpus Zucc. ca. 30 spp.	Mexico, Central America, and South America.
Psyllocarpus Mart. & Zucc. 8 spp.	Brazil; Kirkbride 1979.
Richardia L. 15 spp.;	Mexico, Central America, South America; Lewis and Oliver 1974.
Scandentia E.L. Cabral & Bacigalupo. 4 spp.	Brazil; Cabral & Bacigalupo 2001.
Spermacoce L. ca. 150 spp.	North America, Mexico, Central America, West Indies, and South America; [Including *Borreria* G. Mey.; *Hemidiodia* K. Schum.]
Staelia Cham. & Schltdl. 15 spp.	Brazil.

the mericarp tightly (sect. *Richardia*) or slightly smaller than the mericarp (sect. *Asterophyton* (*K.Schum.*) W.H.Lewis & R.L.Oliv.), oblong or broadly ovate, the dorsal surface convex, the ventral surface with a slightly sunken, central, longitudinal groove, the testa finely reticulate (Fig. 3E,F;4A-F)).

Spermacoce: Ovary usually 2-locular, ovule solitary in each locule. Fruit

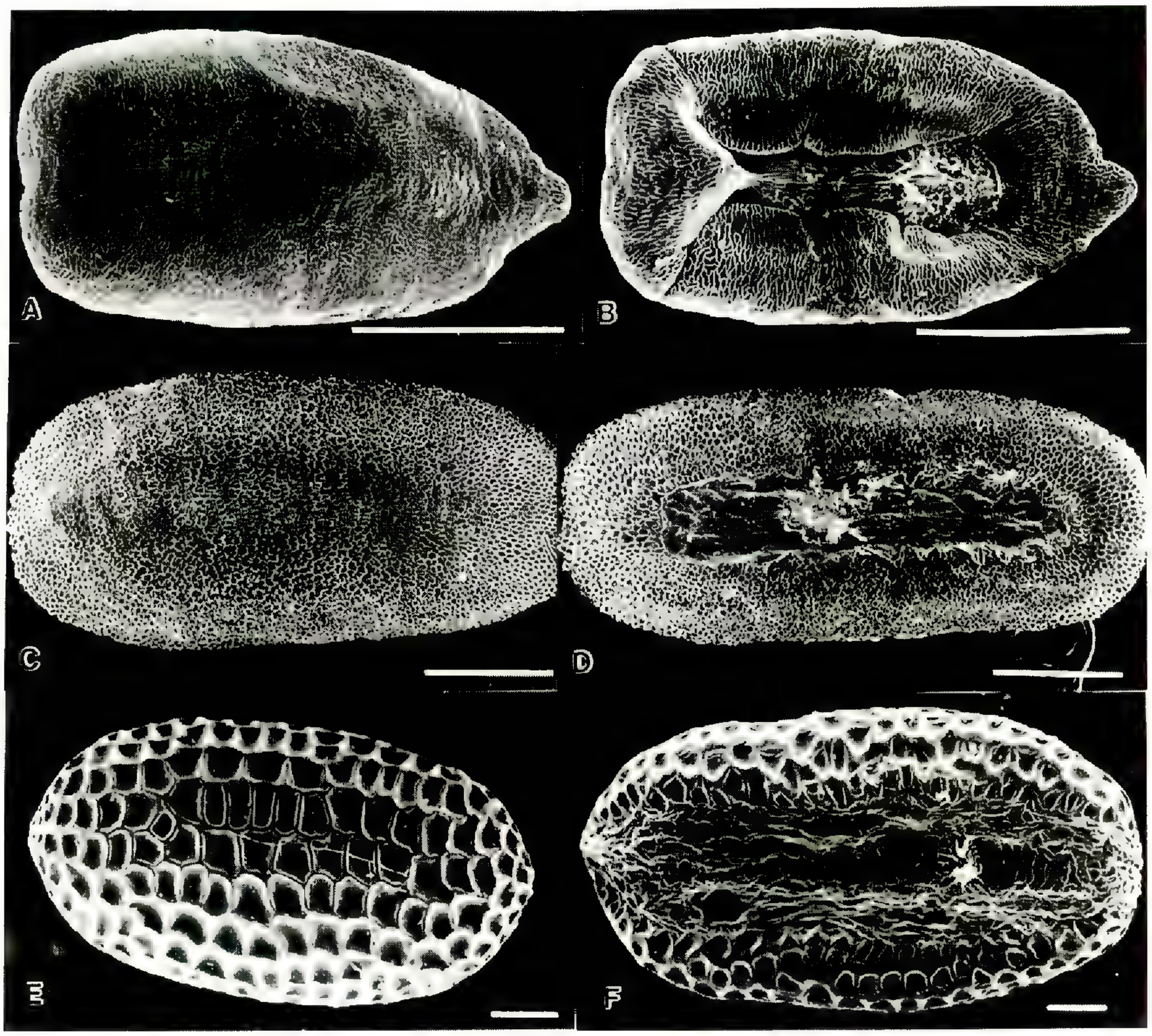


FIG. 1. Dorsal and ventral views of seeds examined by SEM. *Diodia teres* (**A–B**), *D. virginiana* (**C–D**), *Spermacoce prostrata* (**E–F**). Scale bars are 1000 microns (A–B), 100 microns (C–F). Sources of collections listed in Table 1.

dehiscing into 2 mericarps, both opening to release the seed (sect. *Borreria* (G. Mey.) Verdc.) or one mericarp opening to release the seed while the other remains closed by a fragile, easily removable septum (sect. *Spermacoce*). Seeds are ellipsoidal, ovoid, or oblong, the dorsal surface convex, the ventral surface with a slightly sunken, longitudinal groove extending to the ends, this sometimes with small elaiosomes, the testa reticulate (Fig. 1E,F; 2A–F).

DISCUSSION

Some workers continue to treat *Spermacoce* in the broad sense, while others divide it into several genera. *Borreria* is treated either as a separate genus or as a section of *Spermacoce* based on fruit dehiscence (capsule with both carpels opening to release the seeds in *Borreria* or a capsule with 1 carpel opening to release the seed and 1 remaining closed). Based on our study of seed morphology, *Borreria* does not appear to warrant recognition as a genus. Recently,

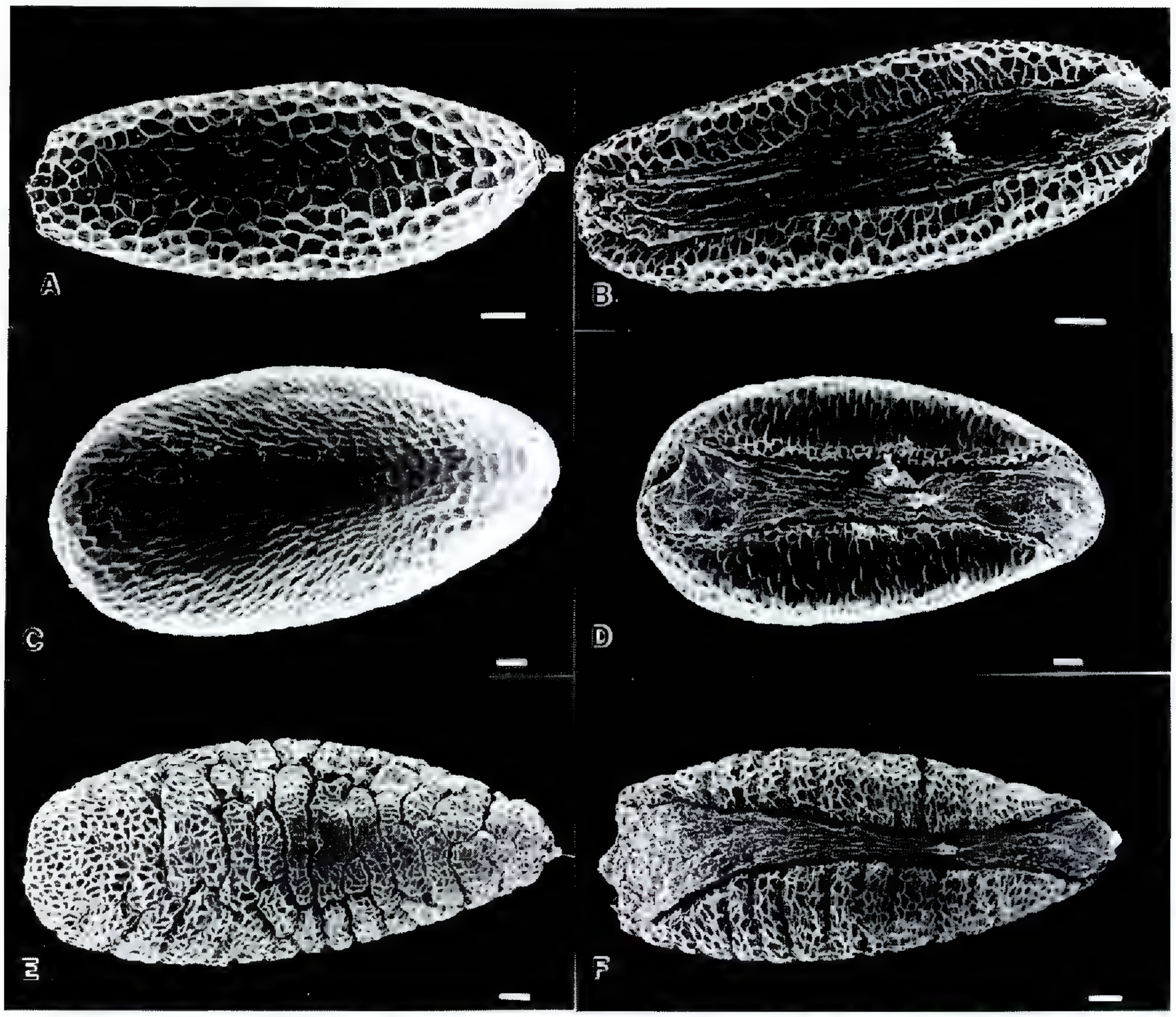


FIG. 2. Dorsal and ventral views of seeds examined by SEM. *Spermacoce verticillata* (**A–B**), *S. tetraquetra* (**C–D**), *S. assurgens* (**E–F**). Scale bars are 100 microns. Sources of collections listed in Table 1.

Galianthe was resurrected as a segregate genus from *Borreria* (Cabral 1991) and *Scandentia* was described (Cabral & Bacigalupo 2001). Both *Galianthe* and *Scandentia* are distinguished from *Borreria* primarily in habit with more or less lax, thyrsoid, apical inflorescences in contrast to the congested, apical and/or axially glomeruliform inflorescences of *Borreria* s. str. *Emmeorhiza*, a monotypic South American genus closely related to *Borreria*, *Galianthe*, and *Scandentia* has an umbelliform inflorescence. The seeds of *Spermacoce assurgens*, *S. prostrata*, and *S. verticillata*, which would be placed in *Borreria* on the basis of fruit dehiscence, do not differ significantly from that of *S. tetraquetra* traditionally placed in *Spermacoce* (Fig. 1E,F; 2A–F). Further work on the *Spermacoce* complex is needed and is underway by various other workers (e.g., E.L. Cabral, N.M. Bacigalupo, and S. Dessein).

Diodia also presents similar problems in circumscription. *Hemidiodia*, a monotypic genus with 2 indehiscent mericarps and long considered closely related to *Diodia*, was transferred to *Borreria* subg. *Dasycephala* (DC.)

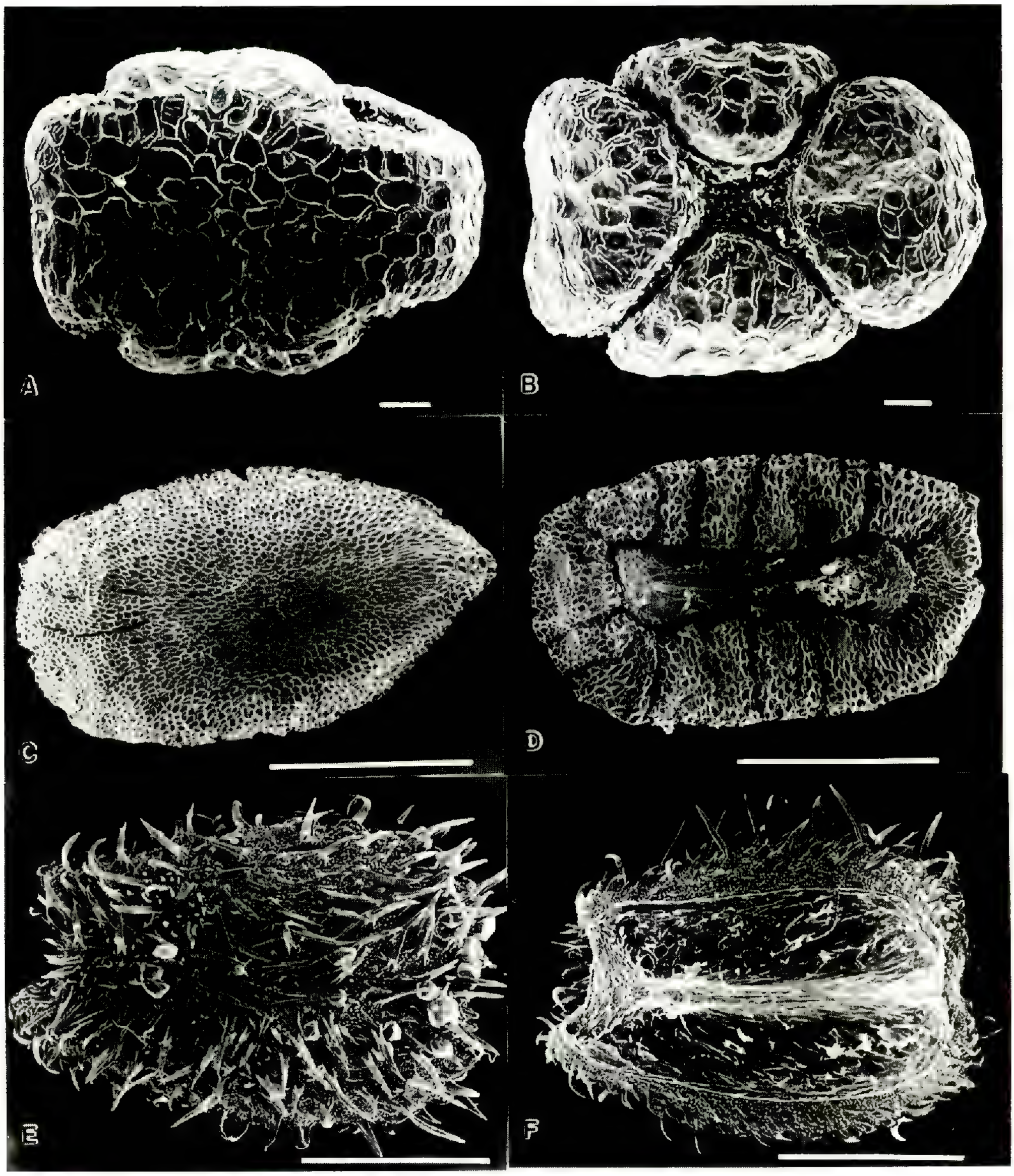


FIG. 3. Dorsal and ventral views of seeds and mericarps examined by SEM. *Mitrocarpus hirtus* seeds (**A–B**), *Ernodea littoralis* seeds (**C–D**), *Richardia brasiliensis* mericarps (**E–F**). Scale bars are 100 microns (A–B), 1000 microns (C–F). Sources of collections listed in Table 1.

Bacigalupo & E.L.Cabral by Bacigalupo and Cabral (1996). Another study by Bacigalupo and Cabral (1999) defined *Diodia* as comprised of only five American species; the other species previously referred to the genus are transferred to *Galianthe* or *Borreria*. These workers exclude *Diodia teres* and related species from *Diodia* s. str. The placement of these species is still under study by Bacigalupo and Cabral. The seed morphology is markedly different between the two southeastern U.S. species, *Diodia virginiana* and *Diodia teres*, exam-

ined in this study (Fig. 1A–D). The seed of *D. virginiana* is oblong with an equally rounded apex and base. The testa has more or less isodiametric cells. In contrast, that of *D. teres* is oblong with an apical projection and a truncate base. On the ventral surface, the base and sides are somewhat enrolled onto the longitudinal groove. The cells of the testa surface are elongate (2–3 times as long as wide). Further study by other workers may prove *D. teres* and related species to be distinct at the generic or subgeneric level.

The seeds of the four *Richardia* species examined are fairly uniform, differ only slightly in size and shape, and the genus appears to be a natural assemblage.

Ernodea seeds and fruits are most similar to those of *Diodia virginiana*.

The seeds of *Mitracarpus* are unique among those examined in this study. The distinct x-shaped groove and the circumscissile dehiscent capsule, both features unique in the tribe, suggest that it may be a distinct subtribe.

The Hedyotideae is much simpler in seed morphology than is the Spermacoceae, but has much more variation in seed shape and size. The seeds are typically in subglobose capsules, each bearing few to many seeds borne on complexly structured placentas. The variation shown by the seeds of the various taxa is very great and each genus, subgenus, or section often has its own particular seed shape. The following are some examples of seed diversity found in the Hedyotideae: (1) *Houstonia* L. has crateriform seeds, each with a ventral subglobose cavity (subg. *Houstonia*) or with a hilar ridge in a ventral shallow depression (subg. *Chamisme* Raf. sect. *Amphiotis* (DC.) Terrell) or with a hilar ridge in a ventral boat- or cup-shaped depression and with other complex structure (subg. *Chamisme* sect. *Ericotis* (Terrell) Terrell) (Terrell et al. 1986, Terrell 1996); (2) *Oldenlandia* L. typically has very small trigonous seeds, 50–100 or more per capsule (Terrell 1996); (3) the *Hedyotis fruticosa* L. group has dorsiventrally compressed seeds with a short to long raised hilar ridge (Terrell 1996); and (4) *Stenotis* Terrell and *Stenaria* (Raf.) Terrell have ellipsoid seeds with a central punctiform hilum (Terrell 2001a, 2001b).

The Spermacoceae, in contrast, have one seed per locule, and the locules develop into varied mericarps. The complexity occurs in the mericarps as well as in the seeds; the seeds examined here do not seem to exhibit much variation, although the *Mitracarpus* seed is an exception. In the Spermacoceae, some mericarps are hardened and indehiscent (e.g., *Diodia*), others are fleshy (*Ernodea*), and some open widely (e.g., *Spermacoce*). Each genus often has its characteristic kind of mericarp, and its structure is important in classification (e.g., *Richardia*, Fig. 4A,B). The mericarps may be more important in classification than the seeds (e.g., our figures show the similarity of seeds among the various genera). The presence of such varied mericarps contrasts with the morphology of the Hedyotideae, which have no such seed covering, just the bare seeds attached to a multi-branched placenta.

An additional seed feature not found in the Hedyotideae is the ventral

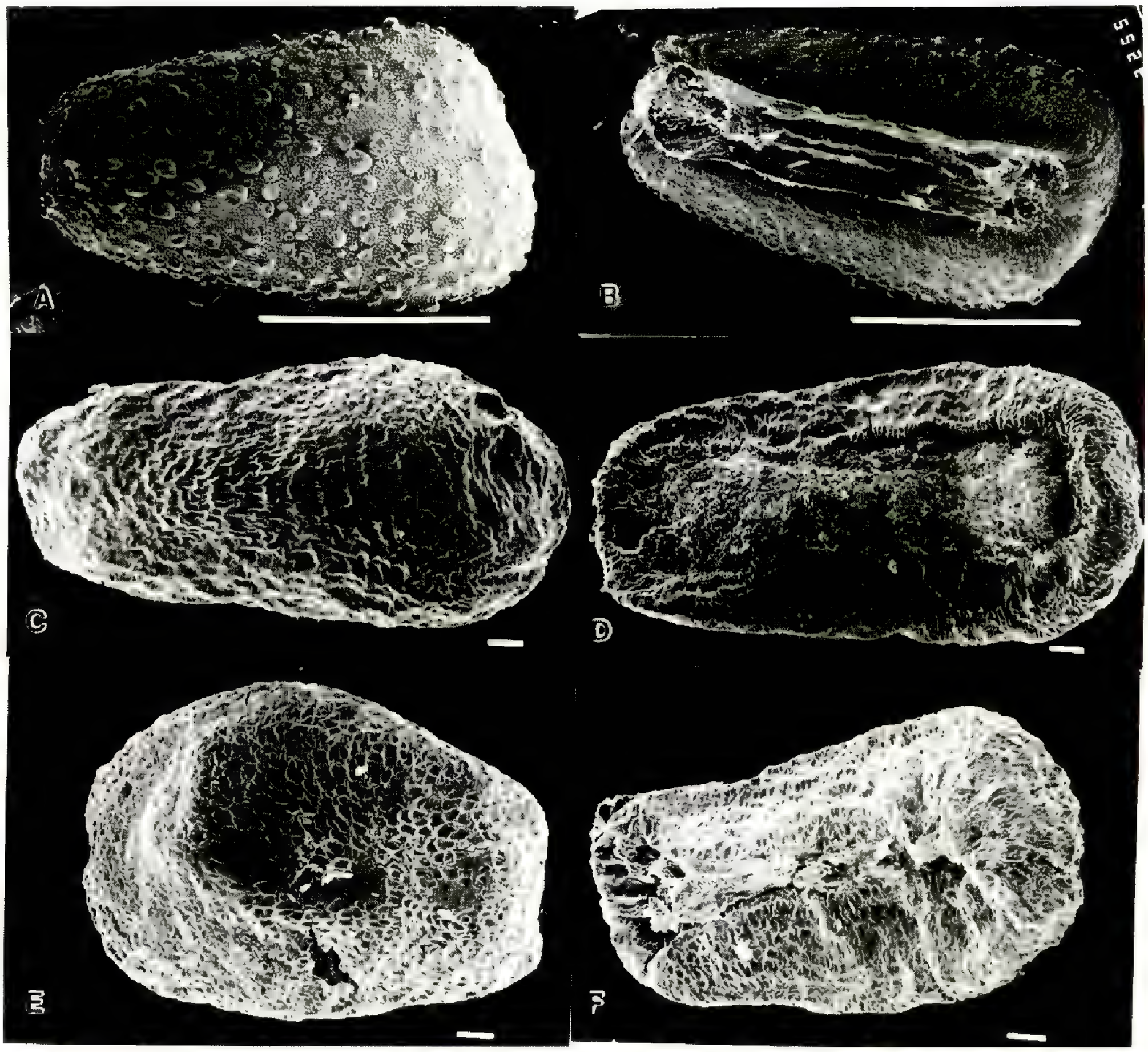


FIG. 4. Dorsal and ventral views of seeds and mericarps examined by SEM. *Richardia scabra* mericarps (**A–B**), *R. humistrata* seeds (**C–D**) and *R. tricocca* seeds (**E–F**). Scale bars are 1000 microns (A–B), 100 microns (C–F). Sources of collections listed in Table 1.

(adaxial) longitudinal groove which resembles a raphe. This structure was designated as a strophiole by Kirkbride (1979), Bacigalupo and Cabral (1996), and other South American botanists. The structure and terminology of this apparent raphe needs further study. It occurs on all seeds of Spermacoceae that we have examined. The Hedyotideae differ in having a so-called hilum, a punctiform scar or a more elongated ridge-top scar on the seed.

Although our evidence from five selected genera represents a limited survey of the possibly 19 genera of Spermacoceae, it is sufficient to lead us to seriously question the union of the Spermacoceae and Hedyotideae.

ACKNOWLEDGMENTS

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Book Notice

J.D. Vertrees. 2001. **Japanese Maples: Momiji and Kaede. Third Edition Revised and Expanded by Peter Gregory.** (ISBN 0-88192-501-2, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $49.95, 332 pp, 312 color photos, 4 maps, 8 1/2" × 11".

A comprehensive source of information on the culture, identification, and nomenclature of Japanese maples, this newly revised classic best seller describes each of the 320 cultivars of *Acer palmatum* and 60 cultivars of other Japanese maple species, plus briefly mentions 150 promising new plants. The second edition was selected in 1997 by the American Horticultural Society as one of the 75 great American Garden Books.

This fully updated third edition has been revised by Peter Gregory, chairman of the Maple Society, and is even more comprehensive than its predecessors. The most extensive revision occurs within Chapter 2: *Taxonomy and Nomenclature*. It adds approximately 100 important new maple hybrids and selections that have been introduced since the last revision by the late J.D. Vertrees in 1987. A total of some 320 *A. palmatum* cultivars are described, along with 60 cultivars of other Japanese maple species. Nomenclature has been updated to conform to current taxonomic standards. The cultivar descriptions in *Chapter 5: Acer palmatum and Its Cultivars* have been placed in alphabetical order rather than by group to make the information more easily accessible. Many additional new photographs have been included, and Vetrees' original photos are clearer and sharper thanks to current reproduction technology. The meanings of Japanese names have been added to the descriptions where possible. This proved impractical in many cases as the meaning could not be determined accurately. *Appendix B: Guide to Uses and Characteristics* provides a summary to assist in the selection of specific plants for individual situations, taking into consideration their ultimate size, habit, color, suitability for companion plantings, and dramatic effect in the garden. The *Index* has been expanded to include all the Japanese maple cultivar names published in books, journals, and major catalogs of growers. The list contains synonyms and alternative names, misspellings and misprints, and names of cultivars which are thought to be no longer in cultivation. The Index alone should continue to make *Japanese Maples* the foremost dictionary and encyclopedic reference for this cultivar.

Japanese Maples will provide guidance for gardeners, landscapers, nursery owners, and others with an authoritative guide to propagation, cultivation, and horticultural characteristics of this extraordinarily useful group of plants. It will meet the needs of all readers, but especially amateur gardeners, avid plant enthusiasts, and commercial nursery professionals.—*Gary L. Jennings, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A.*

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NOTES ON *CARPHEPHORUS ODORATISSIMUS* (ASTERACEAE) IN PENINSULAR FLORIDA, U.S.A.

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ABSTRACT

Morphology, distribution, ecology and phenology for *Carphephorus odoratissimus* and *C. odoratissimus* var. *subtropicanus* are discussed and compared. *Carphephorus odoratissimus* var. *subtropicanus* is illustrated and evidence supporting varietal status is quantified. It occurs in a fire-maintained pine savanna-flatwoods/dry prairie landscape, where it is a conspicuous, perennial, autumn-flowering forb, endemic to south and central peninsular Florida.

RESUMEN

Se discute y compara la morfología, distribución, ecología y fenología de *Carphephorus odoratissimus* y *C. odoratissimus* var. *subtropicanus*. *Carphephorus odoratissimus* var. *subtropicanus* se ilustra y se cuantifican las evidencias que apoyan su estatus varietal. Se da en una sabana/pradera seca de pinos mantenida mediante fuego, es una hierba perenne, otoñal, endémica del sur y centro de la península de Florida.

INTRODUCTION

Carphephorus sensu lat. (Asteraceae-Eupatorieae-Liatrinae) comprises seven species (Correa & Wilbur 1969), and one recently recognized variety (Wunderlin & Hansen 2001) of *Carphophorus odoratissimus*, all of which are endemic to the southeastern United States. Six of these taxa occur in Florida, of which five [*C. carnosus* (Small) C.W. James, *C. corymbosus* (Nutt.) Torr. & A. Gray, *C. paniculatus* (J.F. Gmelin) H. Hebert, *C. odoratissimus* (J.F. Gmelin) H. Hebert, and *C. odoratissimus* var. *subtropicanus* (DeLaney, N. Bissett & Weidenhamer) Wunderlin & B.F. Hansen] are known from peninsular Florida (DeLaney et al. 1999; Wunderlin 1982; Wunderlin et al. 1996; Wunderlin 1998; Wunderlin & Hansen 2001).

The circumscription of *Carphephorus* has been much debated (Hebert 1968; Correa & Wilbur 1969; Cronquist 1980; Cox 1998). Some authors (Hebert 1968; Correa & Wilbur 1969) include *Trilisa* and *Litrisa* within *Carphephorus*, while others recognize them as distinct genera (Cassini 1823, 1828; Robinson 1913; Gaiser 1954; James 1958; King & Robinson 1987; Bremer 1994). Evidence presented by both Hebert (1968) and Correa & Wilbur (1969) support the inclusion of *Trilisa* within *Carphephorus*. Most recent floristic works have adopted this broad definition of *Carphephorus* (Cronquist 1980; Godfrey & Wooten 1981; Long & Lakela 1971; Wunderlin 1982; Wunderlin et al. 1996; Wunderlin 1998).

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In the most recent taxonomic study of *Carphephorus* sensu lato (Correa & Wilbur 1969), *Trilisa* and *Litrisa* are included within *Carphephorus*. Since Correa and Wilbur (1969), no new taxa in *Carphephorus* were recognized until DeLaney et al. (1999), described *C. subtropicanus* DeLaney, N. Bissett, & Weidenhamer. Following DeLaney et al. (1999), Wunderlin and Hansen (2001) treated *C. subtropicanus* at varietal rank within *C. odoratissimus*.

Based upon field observations in the fall of 1995, there seemed to be two entities of *C. odoratissimus* within peninsular Florida. *Carphephorus* specimens from flatwoods and prairie habitats of south-central peninsular Florida seemed somewhat morphologically different from *C. odoratissimus*, as known to us from previous fieldwork in southern Alabama, southern Mississippi, southern Georgia, and the Florida panhandle. Subsequent field investigations and critical taxonomic study of *Carphephorus* conducted from 1995–1997 led us to conclude that the *Carphephorus* entity in south-central peninsular Florida was worthy of recognition. Since that time, our on-going (1998–2001) field investigations and taxonomic studies of Florida *Carphephorus*, particularly in the region of range overlap for *C. odoratissimus* and *C. subtropicanus* in central Florida, lead us to conclude that *C. subtropicanus* should be recognized as a variety of *C. odoratissimus*. In this paper we present ecological, geographical, morphological, and phenological evidence to corroborate Wunderlin & Hansen's (2001) recognition of *C. subtropicanus* at varietal rank. All our data on morphological characters are derived from field sampling of randomly chosen individuals in each of ten populations of these varieties scattered in central Florida. Both entities have mainly separate geographic ranges but intergrade where they are contiguous or overlapping; both exhibit slightly divergent but overlapping flowering phenology; and despite quantitative differences in mean values of vegetative morphology and numbers of flowers per head, they lack differences in achene and floral morphology; all these features are indicative of varietal rather than species level recognition. Phenotypically, *C. odoratissimus* var. *subtropicanus* is distinguished from *C. odoratissimus* var. *odoratissimus* by its lack of a coumarin (vanilla-like odor), shorter and narrower basal leaves, strongly clasping and entire stem leaves, broader and more diffuse inflorescence, and more flowers per head. An illustration of *Carphephorus odoratissimus* var. *subtropicanus* is provided in Figure 1.

TAXONOMIC RELATIONSHIPS

Carphephorus odoratissimus var. *subtropicanus* differs from var. *odoratissimus* most notably in leaf character and some inflorescence characters. Small (1933:1337) noted that "extreme forms" of *Trilisa odoratissima* (= *C. odoratissimus*) might represent two entities, "one with a strong coumarin odor, broad, clasping, coarsely toothed upper leaf -blades and slightly viscid involucres [var. *odoratissimus*], the other with only a faint coumarin odor, narrow entire

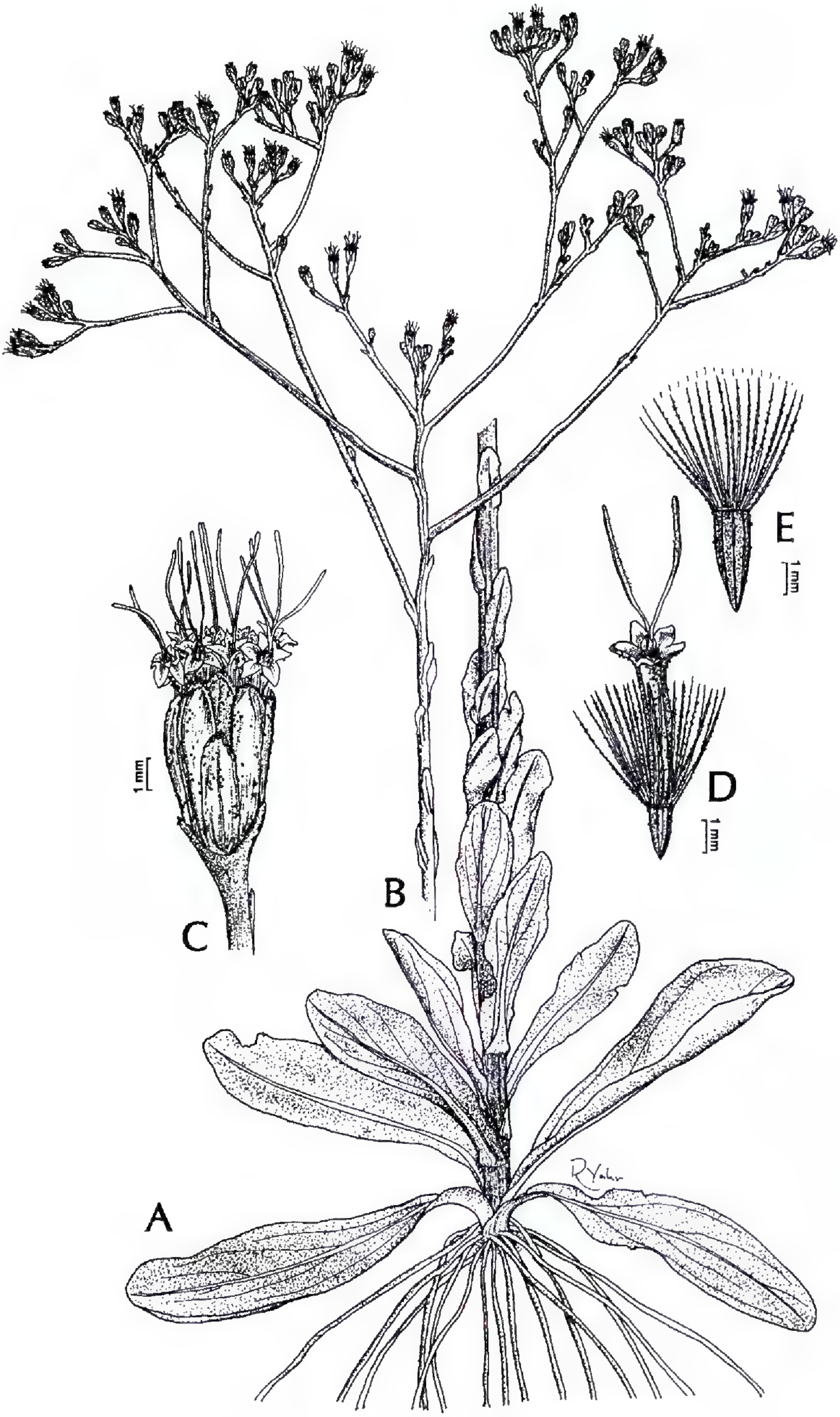


FIG. 1. *Carphephorus odoratissimus* var. *subtropicanus* drawn from *Orzell & Bridges 25,261*. **A.** Habit of base of plant; **B.** Inflorescence; **C.** Single head at anthesis; **D.** Floret at anthesis with pappus and achene; **E.** Mature achene with pappus.

upper leaf blades and very viscid involucres. Small never published the latter as a distinct taxon, and subsequent floristic workers have treated *C. odoratissimus* as a single entity. A revision of the genus (Correa & Wilbur 1969) also failed to account for the two as separate entities. According to Correa and Wilbur (1969), the type of *C. odoratissimus* is "presumably from the outer Coastal Plain of South Carolina ... which was the site of most of the species mentioned in Thomas Walter's *Flora Caroliniana*." Although this type has not been seen by the authors, the collection location is outside the range of *C. odoratissimus* var. *subtropicanus*.

There is considerable character overlap between the two *C. odoratissimus* varieties (Table 1). The presence of numerous quantitative differences in inflorescence and leaf morphology are the most divergent character states. However, the lack of major differences in achene and floral morphology indicates differentiation at the varietal level. One useful character is the average number of inflorescences per clump in well-developed plants. Most plants of *C. odoratissimus* var. *subtropicanus* have one or two flowering stems per clump (mean=1.6, std.=0.8), whereas in central Florida var. *odoratissimus* averages over twice as many inflorescences per clump (mean=4.1, std.=1.9). Several characters of the basal and stem leaves have different mean character states. Although there is wide variation in leaf size and shape between plants within a population in either entity and between lower and upper leaves on individuals, comparison of leaves in the same relative position on plants of the two varieties reveals consistent differences. The basal leaves of *C. odoratissimus* var. *subtropicanus* are both shorter (mean=11 cm) and narrower (mean=3.0 cm) than those of var. *odoratissimus* (mean length=19.8 cm; mean width=5.6 cm). The stem leaves of var. *odoratissimus* are broadly elliptic, and although the base of the leaf clasps the stem, the apex of the leaf is often divergent or flared away from the stem. The margins of the stem leaves in var. *odoratissimus* are often coarsely shallowly toothed. In contrast, the stem leaves of var. *subtropicanus* are narrowly elliptic, clasp the stem for their entire length, and typically have entire margins.

Other characters that differentiate the two varieties involve the size and branching pattern of the inflorescence. The inflorescence of var. *subtropicanus* is much broader than that of var. *odoratissimus*, and on well-developed mature plants it is almost always as broad as tall or broader than tall (height:width ratio mostly from 0.5:1 to 1:1). This difference is mostly attributable to the angle of branching of the primary inflorescence branches from the main axis. The inflorescence branches of var. *subtropicanus* diverge from the main axis at an angle of 30° to 45° and are often arcuate, resulting in a rather open and diffuse inflorescence. In contrast, the main inflorescence branches of var. *odoratissimus* diverge from the main axis at an angle of 10° to 20°, resulting in a narrower, taller, inflorescence that is typically taller than broad (height:width ratio from 1.5:1 to 3:1). This open, diffuse inflorescence, more diffuse than any other species

TABLE 1: Ranges of character states in selected populations of *Carphephorus odoratissimus*.

Character	var. *odoratissimus*	var. *subtropicanus*
Stem height	140–180 cm	50–150 cm
Stems per clump	1–9	1–5
Basal leaf length	17–24 cm	9–14 cm
Basal leaf width	4.5–6.8 cm	2.5–4.0 cm
Inflorescence height:width ratio	1.5:1 to 3:1	0.5:1 to 1:1
Lower stem leaf length	10–15 cm	4–11 cm
Lower stem leaf width	5–7 cm	1.7–4.0 cm
Midstem leaf length	2.2–4.5 cm	1.6–6.0 cm
Midstem leaf width	1.8–3.5 cm	0.8–2.4 cm
Flowers per head	(4–)7–10	(7–)10–14
Involucre height	4–6 mm	7–9 mm
Involucre width	2–3 mm	4–6mm
Achene length	2–2.5 mm	1.9–2.5(–2.8) mm

of *Carphephorus*, is a reliable field character but is often difficult to discern in dried herbarium specimens or plants with an immature inflorescence.

Differences in inflorescence, floral, and achene characters between the two varieties are minor. There is considerable variation even within an individual in the number of florets per head, size of heads, and size of floral parts. *Carphephorus odoratissimus* var. *subtropicanus* tends to have more florets per head (10–13) than is typical for var. *odoratissimus* (7–10). However, this could be attributable to the fact that most var. *subtropicanus* inflorescences consist of only 50–75 heads, in contrast to the hundreds of heads present in some inflorescences of var. *odoratissimus*; therefore a larger proportion of heads fully develop all of their potential florets. We can not find any consistent differences in achene length (1.9–2.5 mm) (–2.8 mm) for *C. odoratissimus* var. *subtropicanus* in comparison to var. *odoratissimus* (2.0–2.5 mm) or other floral characters between the two varieties. DeLaney et al. (1999) also noted overlap in achene length and number of florets per capitulum.

The following key can be used to distinguish the two varieties:

Plants with a strong odor of coumarin or vanilla; basal leaves usually more than 15 cm long and 5 cm wide; midstem leaves broadly elliptic, the apex flared away from the stem, the margins often shallowly toothed; inflorescence taller than broad (height:width ratio of 1.5:1 to 3:1), the primary inflorescence branches diverging from the main axis at a 10° to 20° angle; heads mostly with 7–10 flowers _____ **Carphephorus odoratissimus** var. **odoratissimrus**

Plants with very slight or no odor of coumarin or vanilla; basal leaves less than 15 cm long and 4 cm wide; midstem leaves narrowly elliptic, tightly clasping the stem, the margins entire; inflorescence broader than tall (height:width ratio of 0.5:1 to 1:1), the primary inflorescence branches diverging from the main axis at a 30° to 45° angle; heads mostly with 10–14 flowers _____ **Carphephorus odoratissimus** var. **subtropicanus**

DISTRIBUTION AND ECOLOGY

Carphephorus odoratissimus var. *subtropicanus* is endemic to central and southern peninsular Florida, where it has been collected from 21 counties (Fig. 2), an area encompassing approximately 50,000 sq. km (20,000 sq. mi). It is a conspicuous, autumn-flowering forb of burned pine savanna-flatwoods/dry prairie landscape throughout south-central Florida and is quite frequent in Highlands, Polk, and Okeechobee counties. In the western part of the peninsula, its range extends somewhat further north as compared to the eastern part of its peninsular range. In south Florida, *C. odoratissimus* var. *subtropicanus* is rather infrequent in Collier County, having been collected most frequently in scrubby flatwoods near Immokalee and historically from scrubby flatwoods at Marco Island, the only offshore island location presently known. In southeastern Florida it has been collected from flatwoods and prairies in St. Lucie, Martin, and northern Palm Beach counties. It is not known from the Everglades region of south Florida, presumably due to the absence of acidic pine flatwoods and prairies. There is an historical collection from a sandy low pineland in northern Miami-Dade County, presumably from sandy flatwoods that once occurred on the Atlantic Coastal Ridge.

Carphephorus odoratissimus var. *odoratissimus*, in contrast, is found throughout most of the southeastern United States coastal plain, from southeastern North Carolina south and west to southeastern Louisiana (Correa & Wilbur1969). It is quite common in northern Florida and in southern Georgia and Alabama, where it is typically found in upland longleaf pine (*Pinus palustris* Mill.) dominated woodlands and savannas. Throughout its range var. *odoratissimus* tends to be associated with sandy surface soils that are better drained than those for var. *subtropicanus*. *Carphephorus odoratissimus* var. *odoratissimus* does not occur in South Florida slash pine (*Pinus elliottii* Engelm. var. *densa* Little & K.W. Dorman) dominated flatwoods. However, ranges of both varieties overlap in central Florida. Here *Carphephorus odoratissimus* var. *odoratissimus* seems to reach its southern limit in ecotonal habitats on the lower sideslopes of sandy ridges, both associated with the Central Ridges in extreme northern Polk and Osceola counties and with coastal sand ridges in Brevard, Volusia, Citrus, and Hillsborough counties.

Carphephorus odoratissimus var. *subtropicanus* is characteristic of the pine-savanna flatwoods/dry prairie landscape of the Okeechobee, Osceola, and Desoto Plains (as defined by Cooke 1939; Schmidt 1997) in south-central peninsular Florida. Pine savanna-flatwoods and dry prairie occupy nearly level, inter-drainage flatlands on acidic, low nutrient, poorly drained sandy to sandy clay alfisol or spodosol soils (Abrahamson & Hartnett 1990; Bridges 1997; Orzell & Bridges 1997). Pine savanna-flatwoods are fire-maintained, open-canopied pine stands dominated in south-central Florida either by *Pinus palustris* or *P.*

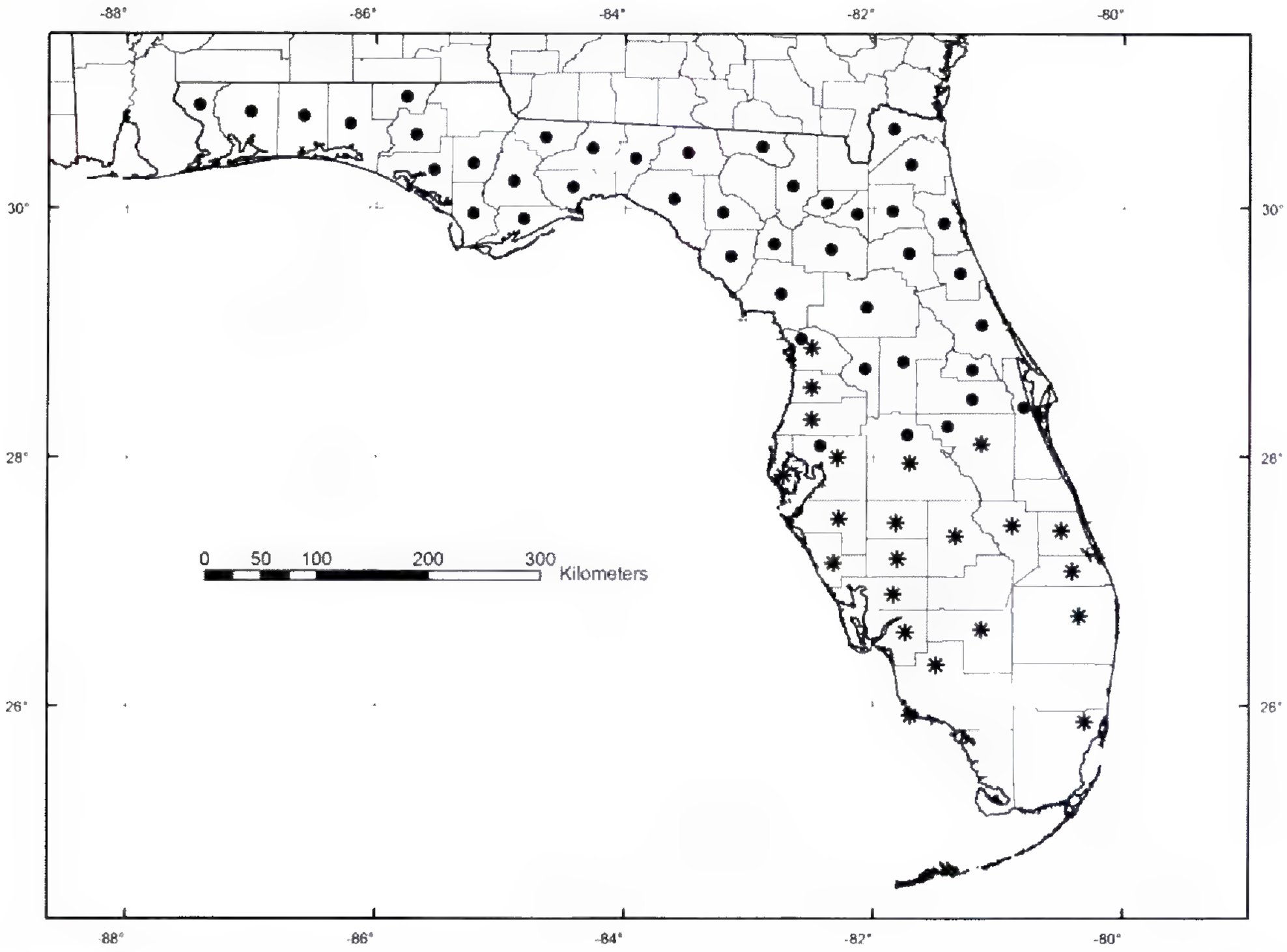


FIG. 2. Florida distribution of *Carphephorus odoratissimus* var. *subtropicanus* (stars) and var. *odoratissimus* (circles). Exact location within county is shown when species is restricted to a single or few locations in a county. For Collier County there are two stars, one for mainland and one for the only known island population on Marco Island. A symbol is placed in center of county when species is widely distributed throughout county. Distribution of *C. odoratissimus* var. *odoratissimus* extends beyond figure north of Florida to North Carolina and west to Louisiana.

elliottii var. *densa*, with *Aristida beyrichiana* Trin. & Rupr., *Serenoa repens* (W. Bartram) Small, and low-growing *Quercus minima* (Sarg.) Small typically dominant in the ground cover as well as numerous regionally endemic species that vary floristically between geographic regions (Orzell & Bridges 1997). Dry prairies are similar in ground cover composition to pine-savanna flatwoods but are naturally treeless. Historically, dry prairies had annual or biennial naturally occurring fires (Harper 1921, 1927; Orzell & Bridges 1999) and are the highest fire-frequented community type in central Florida (Orzell & Bridges 1999). Associated species that are endemic or near-endemic to peninsular Florida include *Asimina reticulata* Shuttlew. ex Chapm., *Polygala setacea* Michx., *Liatris tenuifolia* Nutt. var. *quadriflora* Chapm., *Rhexia nuttallii* C.W. James, *Bejaria racemosa* Vent., *Andropogon brachystachyus* Chapm., *Andropogon ternarius* Michx. var. *cabanisii* (Hack.) Fern. & Griscom, *Gymnopogon chapmanianus* Hitchc., *Phoebanthus grandiflorus* (Torr. & A. Gray) S.F. Blake, and *Polygala rugelii* Shuttlew. ex Chapm.

Carphephorus odoratissimus var. *subtropicanus* can be sympatric with any

of the four other *Carphephorus* species occurring in central Florida. It most often occurs with *C. corymbosus* at drier sites, *C. paniculatus* at mesic sites, and in very rare cases with *C. carnosus* at wet-mesic sites. *Carphephorus* odoratissimus var. subtropicanus is sympatric with var. *odoratissimus* at its northern (Polk and Osceola counties) and northwestern (Citrus and Hillsborough counties) range limits. Plants intermediate between the two are occasionally found in ecotonal and disturbed sites in central Florida where the boundaries of the two overlap. Where the two varieties are sympatric at a site in Osceola County, var. *subtropicanus* grows in dry-mesic poorly drained pine flatwoods, whereas var. *odoratissimus* is found on a somewhat poorly drained slight sandy rise between the pine flatwoods and a wetland depression.

PHENOLOGY

At a disturbed site in Orange County, specimens intermediate in characteristics (leaf morphology, inflorescence, and coumarin odor) between var. *odoratissimus* and var. *subtropicanus* were observed with both flowering in late September 1999. The co-habitation and overlapping flowering at the site of both varieties indicates that ecological separation of the two varieties is incomplete.

In 1997 at an Osceola County site, *C. odoratissimus* var. *odoratissimus* flowered from early September till late October, and *C. odoratissimus* var. *subtropicanus* flowered from late October into November. Elsewhere in central Florida, var. *odoratissimus* generally flowers from early to mid September into late-October and even earlier in north-central Florida (August thru mid-September), whereas var. *subtropicanus* flowers primarily from early to mid October thru early to mid November, with flowering having been noted in September at several locations. Plants flowering in early or late September were also noted by DeLaney et al. (1999). Furthermore, atypical flowering dates for var. *subtropicanus* (usually the result of burning followed by available soil moisture) have been observed. Flowering plants were collected on 2 April 1998 following a 19 August 1997 burn in Osceola County.

APPENDIX 1

Citations here are abbreviated, however full label data is available upon request from the authors, including detailed habitat and location information for the Orzell & Bridges collections.

Representative specimens of *Carphephorus odoratissimus* var. *subtropicanus*. **FLORIDA: Charlotte Co.:** 9 mi N of Placida, off SR 775 & Alt 45, 20 Oct 1977, *Fulton 35* (USF). **Citrus Co.:** SR 480, Chasshowitzka, 7 Oct 1972, *Genelle & Fleming 1606* (FLAS, USF). **Collier Co.:** off Hwy 82 W of Immokalee, 25 Sep1964, *Lakela 27406* (USF). **Miami-Dade Co.:** 7th Ave., N of Miami, 30 Nov 1946, *Ledin s.n.* (FLAS). **Desoto Co.:** oak scrub, ca. 1 mi W of Arcadia on FL 70, 29 Oct 1978, *Wunderlin, Arcuri & Hansen 6386* (USF). **Hardee Co.:** ca. 1 air mi S of Fort Green Springs, 9 Nov 1993, *Hansen & Wunderlin 12435* (USF). **Hendry Co.:** ca. 12.5 air mi SE of LaBelle, 21 Sep 1994, *Orzell & Bridges 23233* (FTG). **Hernando Co.:** ca. 1 mi W of Weekiwachee Springs, 15 Nov 1983, *S. Godley s.n.* (USF). **Highlands Co.:**

Sebring, 24 Oct 1945, *Brass 15613* (ARCH); dry-mesic, sandy, treeless flatwoods/dry prairie, Avon Park Air Force Range, 12 Nov 1997, *Orzell & Bridges 25261* (ARCH, BRIT, FLAS, FSU, MO, NY, TEX, USF). **Hillsborough Co.:** Flatwoods Park, ca.7 mi E of Lutz, 2 Oct 1994, *Wunderlin 10558* (USF). **Lee Co.:** Six Mile Cypress Preserve, 17 Oct 1997, *Bradley 791* (FTG). **Manatee Co.:** ca 1 mi N of Myakka River State Park, 17 Sep 1978, *Dodson 4798* (USF). **Martin Co.:** W of canal, S of Salerno jct. off US 1, 29 Sep1962, *Lakela 25383* (FLAS, USF). **Okeechobee Co.:** US 68, 15 mi N of Okeechobee, 19 Oct 1969, *McCart 11141* (FLAS, USF). **Osceola Co.:** ca. 12 air mi S of Kissimmee, 11 Oct 1997, *Orzell & Bridges 25237* (FLAS, USF); Three Lakes Wildlife Mgt. Area, 2 Apr 1998, *Orzell & Goldman 25263* (USF). **Palm Beach Co.:** Loxahatchee River Corridor, 1 Oct 1997, *Bradley & Woodmansee 559* (FTG). **Pasco Co.:** Upper Hillsborough Flood Detention Area, Zephyrhills, 15 Oct 1974, *Rochow s.n.* (USF). **Pinellas Co.:** Brooker Creek Preserve, 17 Nov 1993, *Hansen 12533* (USF). **Polk Co.:** N of Tick Island Slough, Avon Park Air Force Range, 9 Nov 1994, *Orzell & Bridges 23431* (FTG). **Sarasota Co.:** ca. 5 mi S of Venice, off US 41, 20 Sep 1961, *Lakela 24653* (FLAS, USF). **St. Lucie Co.:** Savanna State Reserve, along E-W track to W side of Savannas, 24 Sep 1992, *Garland 971* (FLAS).

Representative specimens of *Carphephorus odoratissimus* var. *odoratissimus*: **FLORIDA: Alachua Co.:** NW of Gainesville, 14 Sep 1978, *Dunn 171* (FLAS). **Bradford Co.:** 19 Oct 1977, *Conde s.n.* (FLAS). **Brevard Co.:** 16 Aug 1972, *Shuey M0345* (USF); N of Cocoa,11 Oct 1963, *Lakela 26595* (USF). **Calhoun Co.:** S of Blountstown, 28 Sept 1983, *Nelson 2988* (FLAS). **Citrus Co.:** Inverness,10 Nov 1982, *Mawhinney 40* (USF). Crystal River, 6 Jun 1941, *Murrill s.n.* (FLAS). **Dixie Co.:** N of Oldtown, 18 Aug 1937, *Arnold s.n.* (FLAS). **Duval Co.:** Fort Caroline Club Estates, 18 Aug 1963, *Creager 269* (FLAS). **Escambia Co.:** E of Pensacola, 20 Nov 1983, *Wilhelm 11852* (USF). **Flagler Co.:** Palm Coast, 4 Oct 1978, *Tabb s.n.* (USF). SE of Andalusia, 12 Oct 1979, *Hansen, Wunderlin, Sauleda, & Richardson 6719* (USF). N of Andalusia, 18 Apr 1940, *West & Arnold s.n.* (FLAS). **Gilchrist Co.:** E of Trenton, 10 May 1940, *Martin, DeVall & Arnold s.n.* (FLAS). **Hamilton Co.:** N of White Springs, 8 Oct 1966, *D'Arcy 1219* (FLAS). **Hillsborough Co.:** 21 Sep 1967, *Lakela 31111* (USF). **Holmes Co.:** W of Ponce de Leon, 28 Sep 1981, *Hansen 8906* (USF). E of Walton Co line on US 90, 23 Sep 1967, *Blum 2745* (USF). **Lake Co.:** Ocala National Forest, 3 Sep 1976, *Daubenmire s.n.* (USF). **Leon Co.:** Apalachicola National Forest, 29 Oct 1983, *Parker 1790* (USF). **Levy Co.:** vicinity of Cedar Key, 15 Sep 1971, *Carlton, Sreemadhaven, Lakela, & Long 3351*; (USF). Cedar Key Scrub State Reserve, 19 Oct 1990, *Amoroso 521* (FLAS). **Liberty Co.:** Apalachicola National Forest, 9 Dec 1988, *Gholson & Hill 20133* (USF). **Marion Co.:** Silver River State Park, 10 Sep 1990, *Buckner 111* (FLAS). **Okaloosa Co.:** N of Niceville, 26 Sept 1967, *Smith 1196* (FLAS). **Orange Co.:** W of Christmas, 11 Sep 1979, *Hansen & Richardson 6240* (USF) 10 mi S of Oakland, 7 Aug 1958,. *Kral 7745* (USF). **Osceola Co.:** W of Intercession City, 14 Aug 1981, *Hansen & Robinson 8478* (USF). **Polk Co.:** E of Haines City, 2 Sep 1968, *Conard s.n.* (FLAS). Lake Wales, 1 Oct 1964, *Conard s.n.* (FLAS). **Putnam Co.:** Welaka, 16 Jun 1939, *DeVall s.n.* (FLAS). **Santa Rosa Co.:** N of Hernandez Pt., 28 Nov 1980, *Wilhelm 8280* (USF). NE of Holley, 26 Sep 1967, *Smith 2003* (FLAS). **Seminole Co.:** Oviedo, 7 Sep 1947, *Schallert 6762* (USF). **St. Johns Co.:** Faver Dykes State Park, 29 Sep 1983, *Hansen 9857* (USF). W of Cresent Beach, 14 Oct 1941, *West & Arnold s.n.* (FLAS). **Sumter Co.:** Wildwood, 20 Sep 1981, *Correll & Correll 52625* (USF). **Taylor Co.:** US 27, W of Lafayette/Taylor Co. line, 12 Sep 1960, *Ward & Myint 2175* (USF, FLAS). E of Perry, 12 Aug 1956, *Knobloch 1429* (FLAS). **Union Co.:** S of Raiford, 22 May 1942, *West & Arnold s.n.* (FLAS). **Volusia Co.:** Near Ormond, 5 Aug 1943, *Butts s.n.* (USF). **Walton Co.:** S of DeFuniak Springs, 27 Sep 1967, *Smith 2006* (FLAS). **Washington Co.:** N of Chipley, 29 Jul 1954, *Ford 3682* (FLAS). **Alabama: Covington Co:** E of Wing, 20 Oct 1969, *Kral 38120* (USF). **Escambia Co:** Riverview, 27 Nov 1980, *Wilhem 8180* (USF). **GEORGIA: Thomas Co:** N of Boston, 3 Oct 1967, *Morton 2668* (USF). **McIntosh Co:** NE of Sapelo Island, 17 Sep 1956, *Duncan 20544* (USF). **LOUISIANA: Washington Par**: N of Hackley, 16 Sep 1983, *Taylor & Dutton 5618* (USF). **MISSISSIPPI: Harrison Co:** Pass Christian, 22 Oct 1954, *Demaree 36238* (USF). **Jackson Co:** Hurley, 27 Sep 1953, *Demaree 34398* (USF). **Pearl River Co:** I-59 exit 4, 22 Oct 1984, *Hermann 483* (USF). **SOUTH CAROLINA: Beaufort Co:** SE of Yemassee, 6 Sep 1956, *Bell & Ahles 17999* (USF). **Berkley Co:** S of Cross, 23 Sep 1966, *Bradley & Sears 3551* (USF).

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Book Review

David G. Frodin. 2001. **Guide to Standard Floras of the World. Second Edition.** (ISBN 0-521-9077-0, hbk). Cambridge University Press, Cambridge, U.K. $240.00. 1100 pp, 7 1/2" × 10".

The entire history of botanical exploration of the world can be gleaned from this new edition of Frodin's 1100-page bibliography, which is nearly twice as long as edition one (1984). It is a source of an incredible—almost unbelievable—amount of information. We are here dealing with a landmark in literature on plants. The adjective "monumental," though hackneyed, comes to mind.

Floras exist for every part of the world, no matter how remote. In North America north of Mexico, they are available from county level to state-, country-, or even continent level, e.g., *Flora of North America*. Almost every state has its own flora. Canada has a four-volume *Flora of Canada* plus floras for many provinces and all territories. Some floras take years to complete; work on *Flora Brasiliensis*, for example, extended over 66 years. A few never are finished because of lack of funds or botanists. Frodin includes not only full-fledged floras but also checklists and floristic atlases.

Areas covered by floras are of all sizes and shapes. Here are some examples arranged from small to large, with the number of species in each—A small island: the sub-antarctic Macquarie, 46 species; an island group: the Falklands, 256; part of a country: Michigan, 2465; a country: Canada, 4100; part of a continent: North American Great Plains (extreme southern Prairie Provinces of Canada to the Texas panhandle), 3000; and, finally, continents: Australia, 20,000, and Antarctica, 2 native and 1 introduced species.

Frodin's book is arranged by major geographic area, i.e., North America, Asia, Europe, Africa, etc.; within each area are sub-areas (countries, states, islands, etc.). Coverage is strongly 20th century, with ample representation from the 19th and even earlier. All of the book is good reading, including the 1424 footnotes.

Among the tidbits in the Guide are these about Easter Island. The first floristic account of Easter appeared in 1914, with others in 1920, 1922, 1951, 1958, and 1991. The island has 195 species, mostly introduced (only 46 are native). Badly treated by its inhabitants, it is now virtually treeless. One of the trees, the legume *Sophora toromiro*, is extinct except in cultivation off the island. The last record of the tree from the island was by the Thor Heyerdahl 1955-1956 expedition. The island's sole palm is extinct, too, known only from fossil remains.

More tidbits? Which U.S. state has the most plants? Leading the pack are California, 5800, followed by Texas, 4800, and Florida, 3800. North Dakota is last with about 1000.

The compiler of all this wealth, David Frodin, is a botanist at Kew Gardens in England. He spent many years bringing together in one place an abundance of floristic literature; the user is thus spared this prodigious effort. The myriad titles he lists are testimony to the thousands of dedicated botanical explorers who have worked over the centuries to discover and make known the world's plants.—*John W. Thieret, Northern Kentucky University.*

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RESOURCE ALLOCATION PATTERNS AND PHENOTYPIC VARIATION IN THE ENDANGERED TEXAS WILDRICE (*ZIZANIA TEXANA*, POACEAE)

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ABSTRACT

Zizania texana Hitchc., an endangered macrophyte endemic to the upper 4.9 km of the San Marcos River, Hays County, Texas was Federally listed in 1978 after the species experienced a population decline between about 1940 and 1967. Recent interest in restoration has focused attention on the need for a better understanding of the species' response to a variety of microhabitats. This study documents biomass allocation patterns in three microhabitats over 7 months. Current velocities ranged from 0.0–0.010 m/s in the slow site, 0.038–0.142 m/s in the moderate site, and 0.250–0.369 m/s in the fast site. Plants were harvested from each site, on seven occasions, washed, separated into roots, submersed leaves, and reproductive culms with associated leaves and inflorescences, then dried and weighed. At the end of the study, mean total biomass of plants grown in the fast site was 28.42 gdw vs 4.24 gdw for plants grown in the slow site. Resource allocation patterns differed among sites and two distinct phenotypes were apparent. One phenotype, associated with relatively higher current velocities, had higher net productivity, a well-developed root system, and allocated proportionally more biomass to non-reproductive organs (49.2% gdw root biomass in fast site vs 24.8% gdw root biomass in slow site). A second phenotype, associated with relatively slower flowing water, had lower net productivity and allocated proportionally more biomass to reproductive organs (22.1% gdw reproductive culm in fast site vs. 65.0% gdw reproductive culm in slow site). Because of lower productivity and the potential for loss from herbivory to a significant proportion of the plant in slower flowing water, a microhabitat with relatively low current velocity would not be recommended for restoration purposes.

RESUMEN

Zizania texana Hitchc., un macrófito en peligro, endémico de los 4.9 km superiores del río San Marcos, Hays Co., Texas se incluyó en la lista Federal en 1978 después que la especie experimentase una reducción poblacional entre 1940 y 1967. El interés reciente en la restauración ha prestado atención a la necesidad de una mejor comprensión de la respuesta de la especie a una variedad de microhábitats diferentes. Este estudio documenta los modelos de situación de biomasa en tres microhábitats durante 7 meses. Las velocidades normales variaron entre 0.0–0.010 m/s (el sitio lento), 0.038–0.142 m/s (en el sitio moderado), y 0.250–0.369 m/s (en el sitio rápido). Las plantas se cosecharon de cada microhábitat, en siete ocasiones, se lavaron, separaron las raíces, las hojas sumergidas, y los cúlmenes reproductores con las hojas e inflorescencias asociadas, luego se secaron y pesaron. A final del estudio, la biomasa total media de plantas del sitio rápido fue 28.42 gdw contra 4.24 gdw para plantas del sitio lento. Los modelos de recursos difirieron significativamente entre los diferentes sitios y fueron aparentes dos fenotipos claros eran. Un fenotipo asociado con velocidades actuales relativamente más altas, tenía una productividad neta más alta, un sistema radical bien desarrollado, y colocó proporcionalmente más biomasa en órganos vegetativos (49.2% de peso seco de biomasa de raíz en el sitio rápido contra 24.8% de peso seco de biomasa de raíz en el sitio lento). Un segundo fenotipo,

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asociado con agua de corriente relativamente más lenta, tuvo una productividad neta más baja y colocó proporcionalmente más biomasa en los órganos de reproductores (22.1% de peso seco de biomasa en cúlmenes reproductores en el sitio rápido contra. 65.0% de peso seco de biomasa en cúlmenes reproductores en el sitio lento). A causa de tasas bajas de productividad y la pérdida potencial debida a los herbívoros en una proporción significativa en el agua de corriente más lenta, este tipo de microhábitat no se debería recomendar para las restauraciones.

INTRODUCTION

Trade-offs between reproductive allocation and vegetative allocation with changes in environmental conditions have been reported by Harper and Ogden (1970); Hickman (1975); van Baalen, et al. (1990); Dunn and Sharitz (1991); Madsen (1991) and Neill (1993). Environmental factors associated with allocation trade-offs include substrate, nutrient availability, and water depth (Idestam-Almquist & Kautsky 1995; Blanch et al. 1999; Lorenzen et al. 2001; Vretare et al. 2001). Little information is available on current velocity and its affect on allocation patterns in macrophytes although numerous studies have identified current velocity as an important factor influencing macrophyte distribution, photosynthesis and growth (Nilssen 1987; Chambers et al. 1991; Madsen & Søndergaard 1983; Power 1996a). The work reported here was undertaken to document resource allocation patterns in the endangered *Zizania texana* Hitchc. over seven months in three different habitat types differing in current velocity and pH.

Zizania texana is an endangered macrophyte endemic to the San Marcos River, Hays County Texas (U.S. Fish & Wildlife Service 1995). It commonly occurs midchannel in swiftly flowing water. Terrell et al. (1978) and Poole and Bowles (1999) provide thorough descriptions of the habitat for *Z. texana*. Threats to the species include reduced spring flow from the source aquifer due to overpumping of ground water for human use, competition and herbivory by nonnative plant and animal species, and absence of sexual reproduction in the wild, along with other human impacts including alteration of historic hydrologic patterns from dams located along the river and within the watershed, and recreational use (U.S. Fish & Wildlife Service 1995).

Under flowing water conditions, *Z. texana* produces long ribbon-like, submersed leaves and emergent culms, each with a terminal, wind pollinated inflorescence; however, sexual reproduction is nearly absent in the wild (U.S. Fish & Wildlife Service 1995). Historical accounts suggest this was not always the case. Photographs depicting fully developed inflorescences and verbal accounts suggest recruitment by seed occurred (Silveus 1933). More recent descriptions of floral structures and floral development by Emery and Guy (1979), and Power (1996b; 1997) indicate that sexual reproduction is most likely limited by environmental factors rather than cytological factors. It is not well understood why fully developed, emergent inflorescences are rare in the wild, although drifting mats of floating vegetation and herbivory play a role (Power 1996b, c). The spe-

cies produces asexual clones (tillers) which form at the nodes of reproductive culms and it is assumed that tiller production is the primary mechanism for recruitment of new individuals in the wild (U.S. Fish & Wildlife Service 1995).

Zizania texana has two distinct phenotypes under wild and cultured conditions. When grown in the wild, *Z. texana* is primarily submersed and tends to be a long lived perennial plant. Under cultivated conditions, *Z. texana* is primarily emergent, reproductive, and short lived (Terrell et al. 1978 and pers. observ.). Information on plant response to environmental conditions, gains importance given the endangered status of the species and the need for restoration of the habitat as outlined in the Recovery Plan for the species (U.S. Fish & Wildlife Service 1995). Adequate restoration protocols cannot be developed without a thorough understanding of the response of *Z. texana* to a variety of conditions found in its historic range.

METHODS AND MATERIALS

This research project was carried out in Spring Lake on the Southwest Texas State University (SWT) campus. Spring Lake is an impoundment formed by a dam and spillway originally constructed across the San Marcos River in 1849. The dam and spillway are approximately 750 m downstream from the San Marcos Springs.

Study plants were obtained by germinating captive grown seed in the lab. Seedlings were then transplanted to 15 cm plastic pots, lined with small plastic bags and filled with sediments collected from one location in the study site in Spring Lake. Pots were placed in an outdoor cement raceway on the SWT campus and seedlings were allowed to grow for about 6 weeks. Water was supplied by an artesian well from the source aquifer for Spring Lake and the San Marcos River. In March 1995, potted plants were transplanted into three sites in Spring Lake and one site in the outdoor raceway on the SWT campus. This was a nested design with plants nested in plots and plots nested in sites. There were three replicate plots at each site. Each replicate plot had 36 potted plants for a total of 432 plants. All plants were protected from herbivores with 1 m^3, floating exclosures constructed of polyvinyl chloride (PVC) pipe and 2.5 cm wire mesh. Initially, four plants were harvested to obtain baseline biomass values for the newly transplanted individuals. The study design called for harvesting four plants from each replicate plot on nine separate occasions. However, during the study period some plants were lost to herbivory and some plants were washed away by the current. As a result, plants were harvested from each replicate plot on six dates, May 3, June 1, June 30, July 27, September 1, and October 16. At each harvest, plants were selected at random. Sediment was washed from plant roots, then plants were divided into vegetative parts, reproductive parts, and roots. Vegetative parts were defined as submersed leaves and reproductive parts were defined as reproductive culms with associated leaves, inflorescences, seeds,

and tillers. Plants were then dried at 65°C for at least 48 hours and weighed to the nearest 0.01 g. Data are reported as means plus-minus standard error.

On nine occasions between May 1995 and October 1995 pH, water depth, and current velocity were recorded in each replicate plot, in each site. Current velocity was measured with a Marsh McBirney Model 201 portable water current meter and calculated as the average velocity at 20%, 60%, and 80% depth. The four sites differed in mean current velocity and were identified as follows: slow (raceway), no flow, moderate and fast.

RESULTS

Plants in the no flow site in Spring Lake were lost to herbivory, probably by crawfish, prior to the second harvest and this site was dropped from the study.

Water depth, current velocity, and pH at the remaining sites were recorded at the study sites eight times between May and October (Table 1). In the slow site, mean water depth was 0.71 m (±0.03) mean current velocity was 0.001 m/s (±0.004), and pH ranged from 7.50 to 7.68. In the moderate site, mean water depth was 0.88 m (±0.06), mean current velocity was 0.090 m/s (±0.048), and pH ranged from 7.23–7.26. In the fast site, mean water depth was 0.85 m (±0.07), mean current velocity was 0.290 m/s (±0.076) and pH ranged from 7.16–7.28.

Plants in all study sites increased in size during the study period (Fig. 1). At each harvest, fast site plants had the greatest root, submersed leaf, and total net biomass, furthermore, data from the September harvest showed mean net total biomass of fast site plants was an order of magnitude greater than mean net total biomass of slow site plants (34.05 g vs. 3.66 g).

Number of submersed leaves increased in all sites during the study period, however fast site plants produced six times as many submersed leaves as slow site plants. At the end of the study period, mean number of submersed leaves in fast site plants was 18.0 (± 1.414) while mean number of submersed leaves in slow site plants was 3.0 (± 0.211).

Reproductive culms were present in every harvest between 1 June 1995 and 16 October 1995. Culm number was greatest during the September harvest in plants grown in the fast site with 2.9 (± 0.380) culms/plant. For plants grown in the slow site, number of culms was greatest in the October harvests with 1.6 (± 0.159) culms/plant. (Fig. 2).

Biomass allocation to plant roots and reproductive culms varied through time and among sites (Fig. 3). The proportion of biomass allocated to roots increased from 27% in March at the beginning of the study to 49% in October in plants grown in the fast site. In contrast, the proportion of biomass allocated to roots decreased from 27% at the beginning for the study to 25% at the end of the study in the slow site.

Plants in all sites produced similar numbers of culms, however biomass allocation varied greatly among sites. In October, culm biomass constituted over

TABLE 1. Means and ranges for environmental factors in two sites (Moderate and Fast) in Spring Lake and one site (Slow) on the SWT campus. Data were collected on nine separate days between May 1995 and October 1995.

	Slow	Moderate	Fast
Depth (m)			
mean (sd)	0.71 (±0.03)	0.88 (±0.06)	0.85 (±0.07)
range	0.69–0.75	0.87–0.91	0.80–0.87
Current velocity (m/s)			
mean (sd)	0.001 (±0.004)	0.090 (±0.048)	0.290 (±0.076)
range	0–0.010	0.038–0.142	0.250–0.369
pH			
range	7.50–7.68	7.23–7.26	7.16–7.28

half of total plant biomass in slow site plants (65%; culm number = 1.6±0.159), in moderate site plants, 48% of total net biomass was culm biomass (culm number = 1.7±0.129 and fast site plants allocated only 22% of total net biomass to reproductive culms (culm number = 2.25±1.591).

The proportion of biomass allocated to submersed leaves was similar among sites even though the number of leaves varied among sites. In October, submersed leaf biomass was 29% of total biomass in the fast site (leaf number = 18±1.414), 15% of total biomass in the moderate site (leaf number = 5.3±1.862), and 28% of total biomass in the slow site (leaf number = 3±0.211).

DISCUSSION

In this study, plants exhibited markedly different growth patterns among study sites. Net total biomass accumulated over the study period was an order of magnitude greater in plants grown in water flowing between 0.146–0.442 m/s compared with plants grown in water flowing between 0–0.01 m/s. Net biomass accumulation in individual plant organs (roots, submersed leaves, and reproductive culms) also was greater in fast flowing water compared with slow flowing water. Submersed leaf biomass was 18 times greater in fast site plants compared with slow site plants and 4.5 times greater compared with moderate site plants. *Zizania texana* exhibited a similar response to flowing water in other studies (Power 1996a, b).

Flowing water has been shown to influence macrophyte photosynthetic rates (Westlake 1967; Smith & Walker 1980; Madsen & Sondergaard 1983), distribution (Fonseca & Kenworthy 1987; Nilssen 1987); and growth (Chambers et al. 1991). Plants occur in a range of current velocities and there is considerable variability in optimum flow rates for macrophytes. Chambers et al. (1991) found an inverse relationship between biomass and current velocity between 0.01–1.0 m/s. Nilssen (1987) found species richness reached a peak at about 0.3

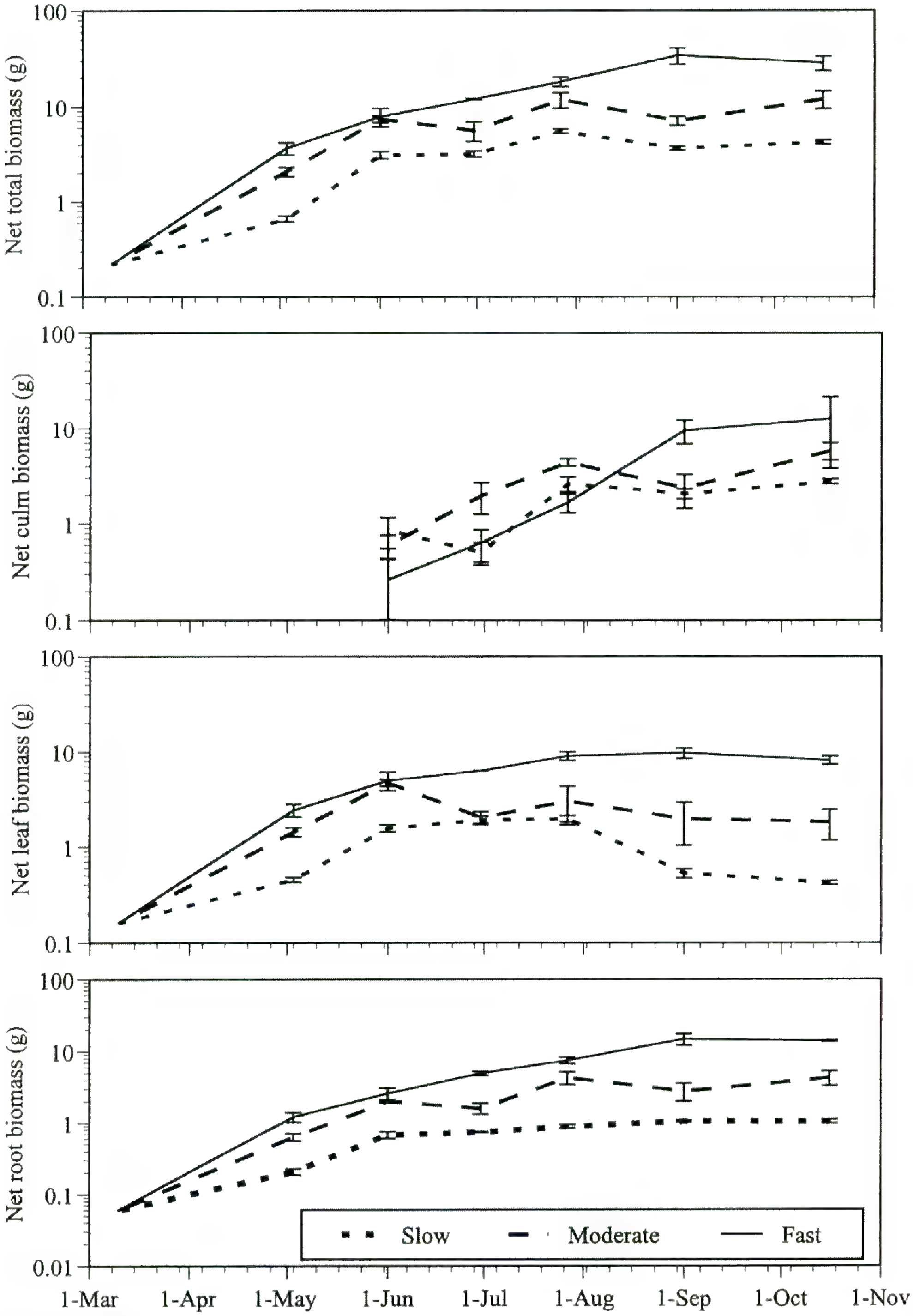


FIG. 1. Growth by potted *Zizania texana* over 7 months from two sites in Spring Lake (fast and moderate sites) and one site at Southwest Texas State University (slow site). After 7 months, plants grown in the fast site had the greatest net root, net leaf, net culm, and net total biomass compared with the other two sites. Points on graph represent the mean ± standard error.

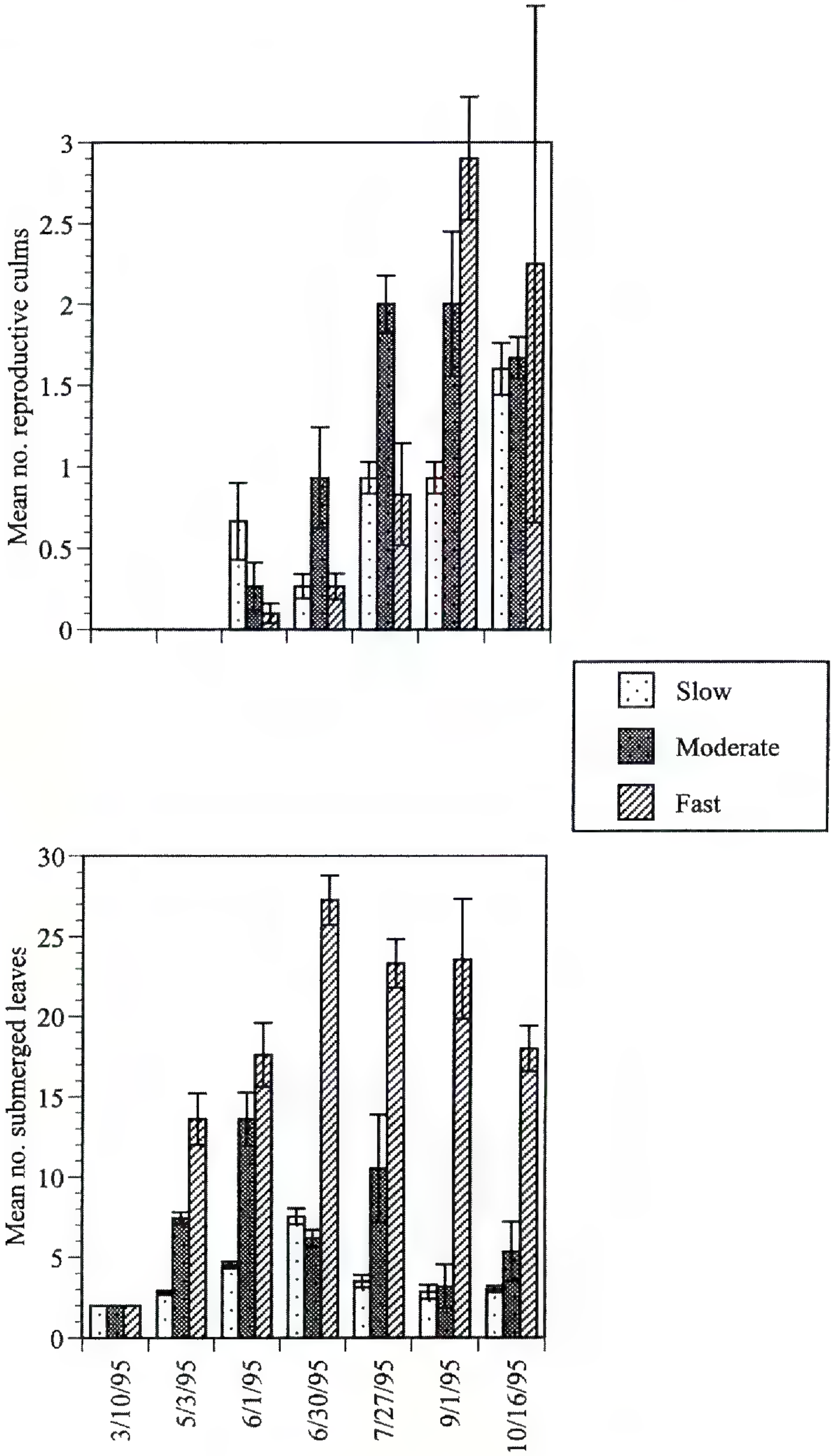


FIG. 2. Number of submersed leaves and reproductive culms from potted *Zizania texana* harvested over 7 months from two sites in Spring Lake and one at Southwest Texas State University. Plants grown in fast flowing water produced more submersed leaves and reproductive culms compared with plants grown in slow flowing water. Vertical bars represent ± standard error.

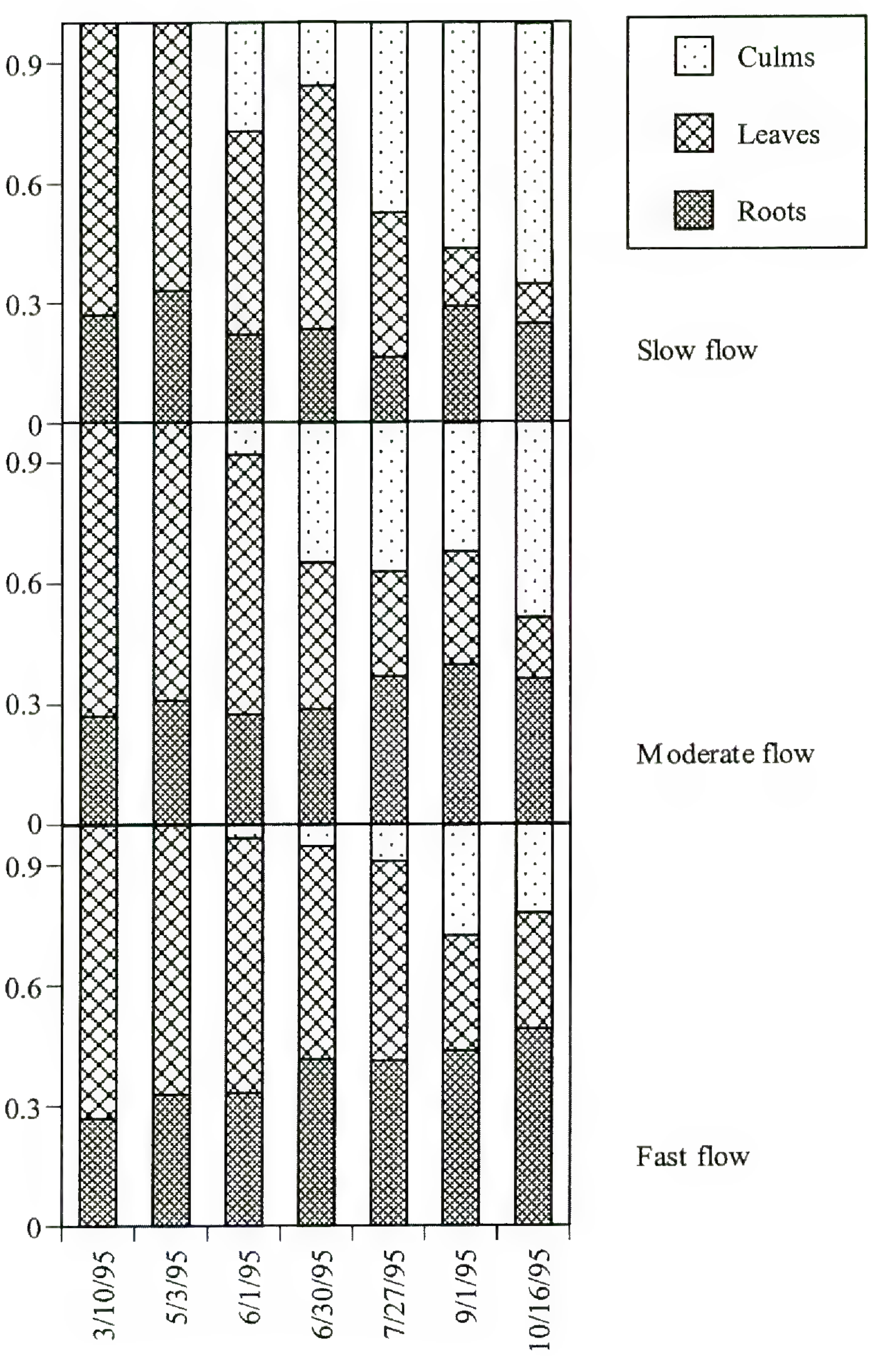


FIG. 3. Proportional allocation of plant mass to roots, leaves, and reproductive culms when grown under three current velocities over 7 months. Biomass allocation to plant roots and reproductive culms varied among sites. There was little difference in the proportion of plant mass allocated to submersed leaves among sites.

m/s along a current gradient from 0.04–1.23 m/s, with some species growing in current velocities greater than 1 m/s. Many species occur in slower current velocities, while fewer species are specialized to withstand the forces of velocities over 0.3 m/s. Apparently, *Z. texana* with smooth, ribbon-like leaves is one of few species able to withstand velocities over 0.3 m/s. Poole and Bowles (1999) found wild *Z. texana* stands primarily in current velocities > 0.46 m/s and the current velocity tolerance range for *Z. texana* exceeds 1.0 m/s; from this study however, it was not possible to identify a maximum or an optimum current velocity for growth.

Zizania texana exhibits phenotypic variation in response to current velocity. One phenotype, associated with relatively higher current velocities, has higher net productivity, a well-developed root system, and allocates proportionally more biomass to nonreproductive organs. A second phenotype, associated with relatively slower flowing water, has lower net productivity and allocates proportionally more biomass to reproductive organs. Plants face a tradeoff between the need for a well-developed root system to anchor plants in potentially unstable sediments, the need for submersed leaves with which to photosynthesize, and the need for emergent stems for reproduction. In this study, the proportional allocation to nonreproductive organs (roots and submersed leaves) decreased with decreasing current velocity as the proportional allocation to reproductive organs increased. Apparently there is a trade-off in favor of submersed organs in faster flowing water.

Other factors directly and indirectly influenced by current velocity may play a role in net biomass accumulation in plant organs. They include herbivory, deposition of debris and sediments on leaves interfering with metabolic processes, colonization of leaves with epiphytes, and the plant's inability to utilize HCO_3^- and its dependence on CO_2 as an inorganic carbon source (unpublished data). Ribbon-like submersed leaves of *Z. texana* are adapted to withstand the forces of flowing water and can reduce carbon limitation by exploiting flowing water habitat where boundary layer surrounding leaves and diffusion distances for CO_2 are reduced, and leaves are continually bathed with carbon rich water. In contrast, in slower flowing water, photosynthesis by submersed leaves of *Z. texana* is carbon limited and few submersed leaves are produced. Emergent reproductive culms with associated emergent leaves most likely are not carbon limited because culms obtain CO_2 from the atmosphere where CO_2 is more readily available owing to the higher diffusion rate and current velocity in air relative to water (Madsen & Sand-Jensen, 1991; Denny 1993).

Increased proportional allocation to emergent reproductive organs in relatively slower flowing water concurs with observations of captive grown *Z. texana* when grown in current velocity ≈0.015 m/s in which plants allocate a greater proportion of biomass to reproductive organs and typically set seed and senesce after one growing season. This is similar to *Z. palustris* and *Z. aquatica*,

annual species which commonly occur in shallow water along the margins of lakes and streams (Ferren & Good 1977; Weir and Dale 1960). The importance of having leaves and flowers above the surface of the water may be due to CO_2 limitation in submersed leaves. In relatively slower flowing water, gas exchange and photosynthesis may be insufficient to support vegetative organs and resources shift to emergent organs where CO_2 is plentiful.

Herbivory is a factor contributing to sexual reproductive failure in *Z. texana* (U.S. Fish & Wildlife Service 1995; Power 1996c). Plants growing in microhabitats with relatively slow flowing water and potentially over 60% of biomass allocated to reproductive parts, are especially vulnerable to herbivory by waterfowl. Microhabitats with conditions which would trigger a low productivity/high reproductive phenotype in the wild include back eddies and protected stream edges, emergent macrophyte beds, impoundments upstream from dams, and potentially, reduced springflows due to drought and overpumping of the source aquifer (the Edwards Aquifer) for human use. These microhabitats would not be recommended as possible *Z. texana* restoration sites.

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NOMENCLATURE OF THE HEART-LEAVED HEDGE-NETTLE, *STACHYS CORDATA* (LAMIACEAE)[1]

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ABSTRACT

Stachys cordata Riddell is the correct name for the species usually called *S. nuttallii* Shuttlew. ex Benth.

RESUMEN

Stachys cordata Riddell es el nombre correcto para la especie usualmente conocida como *S. nuttallii* Shuttlew. ex Benth.

Stachys cordata was described from Ohio by Riddell in 1836. The identity of the species so named was never in question, and the use of this name prevailed during the following 85 years. Riddell's type specimen is extant at US and microfiches are widely accessible.

In 1921, House published the name *Stachys riddellii* in direct substitution for *S. cordata* Riddell, although he inappropriately used the designation "n. sp." Because this was merely a new name for the same species, no new description was provided and no new type was cited. House considered the name *S. cordata* Riddell to be illegitimate, in that it was a homonym of *S. cordata* Gilib. Whether the new plant names in Gilibert's *Flora Lituanica Inchoata* should be considered validly published under the provisions of the *International Code of Botanical Nomenclature* was formerly a matter of doubt. This matter is now settled. *Flora Lituanica Inchoata* and Gilibert's other publications are listed in the *Code* among the "opera utique oppressa," and new names at the rank of species are decreed not to have been validly published in those works.

Immediately upon its being published, the name *Stachys cordata* Gilib. was widely recognized as being taxonomically synonymous with *S. sylvatica* L., the name of a species native to Europe. Consequently, it was not inadvertently validated by subsequently being accepted by any other author. Bentham, in his comprehensive treatment of the genus in 1848, did not note the use of this name by any other authors in the interim, nor did he even cite it in synonymy. Since the provisions of the *International Code of Botanical Nomenclature* pertaining to homonyms apply only to validly published names, the use of the combination

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by Gilibert no longer constitutes a reason for rejecting the name *S. cordata* Riddell.

Following House's publication of the name *S. riddellii*, that name came into general use for the species, although as late as 1933 the name *S. cordata* was used in Small's *Manual of the Southeastern Flora*. In 1979, Nelson and Fairey noted that the long-misapplied name *S. nuttallii* Shuttlew. ex Benth. (1848), which antedated *S. riddellii* House, was correctly applicable to the same species. The species has usually been called *S. nuttallii* since their paper was published. They rejected the name *S. cordata* Riddell only for the reason given by House. In his monograph on *Stachys* in the southeastern United States, Nelson (1981) included *S. cordata* Riddell in the synonymy of *S. nuttallii* but did not address the question of the legitimacy of the earlier name.

The only post-1981 flora in which the name *S. cordata* Riddell was accepted is that by Gleason and Cronquist (1991). The names *S. riddellii* and *S. nuttallii* were cited in synonymy, without comment. In other standard references, both printed and electronic and including those published since 1991, the name *S. nuttallii* has continued to prevail.

I conclude that there is no basis for the rejection of the name *Stachys cordata* Riddell, and that it is the correct name for the species that has been called *S. riddellii* House and *S. nuttallii* Shuttlew. ex Benth.

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A CYPRESS (*CUPRESSUS ARIZONICA*, CUPRESSACEAE) IN JEFF DAVIS COUNTY, TEXAS?

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ABSTRACT

We investigated a recent report of a disjunct individual of *Cupressus arizonica* (Cupressaceae) collected in the Davis Mountains of Jeff Davis County, Texas. Chloroplast DNA sequences were obtained for the novel disjunct specimen and putative related taxa. Phylogenetic analysis suggests that the Davis Mountains *C. arizonica* specimen consists of vegetative tissue from *Juniperus deppeana*, a common species of the Davis Mountains. Based on this evidence, the present known distribution of *C. arizonica* in Texas remains restricted to the Chisos Mountains of southern Brewster County.

RESUMEN

Hemos investigado un reciente registro de un individuo disyunto de *Cupressus arizonica* (Cupressaceae) colectado en las montañas de Davis del condado de Jeff Davis, Texas. Se obtuvieron secuencias de ADN cloroplastidial del nuevo registro y los supuestos taxa relacionados. El análisis filogenético muestra que el especimen de *C. arizonica* de las montañas de Davis consiste en tejidos vegetativos de *Juniperus deppeana*, una especie común de las montañas de Davis. En base a esta evidencia, la actual distribución de *C. arizonica* en Texas, permanece restringida a las montañas Chisos del condado de Brewster.

INTRODUCTION

Cupressus arizonica, as broadly circumscribed (Wolf & Wagener 1948; Eckenwalder 1993) includes a number of variable, isolated populations in southwestern North America. The recent report of a single individual of *Cupressus arizonica* at Bridge Gap Spring in the Davis Mountains of Jeff Davis County, Texas (Karges & Zech 2001) suggests a more continuous distribution in suitable habitats from California, through the southwestern United States, into Trans-Pecos Texas, and south into Mexico. Previously, *C. arizonica* was known from northern Mexico (Standley 1920; Wolf and Wagener 1948; Little 1978 Correll & Johnston 1979; Rehfeldt 1997) southern Brewster County, Texas (Powell 1988; 1998), and isolated localities in Arizona, California, and New Mexico (Sudworth 1927; Vines 1960; Little 1971; Minnich & Everett 2001). The Davis Mountains specimen led Karges and Zech (2001) to postulate a greater Pleistocene range for *C. arizonica*, represented by an occurrence in this additional Madrean sky island habitat.

The specimen upon which this phytogeographic postulate is based (*Karges & Hedges 2480, SRSC*) may not represent *Cupressus arizonica*, however. This

sheet consists of several short (< 12 cm), separate, yellowed terminal branches, and three small (< 8 mm), detached woody scales. Another voucher of the Bridge Gap putative *Cupressus arizonica* (*Karges s.n., SRSC*) consists of a single branch with green leaves, but no visible reproductive structures. Common members of the Cupressaceae that occur in the Davis Mountains are *Juniperus deppeana* var. *deppeana* and *J. pinchottii* (Powell 1998). Also present in the Davis Mountains, *J. deppeana* var. *sperryi* is an extremely rare endemic known from three individuals (Adams 1973; 1993; Watson & Eckenwalder 1993; Powell 1998). The Bridge Gap specimens could represent one of the above taxa, as concluded by B.L. Turner in an annotation (17 Jan 2001) of *Karges and Hedges 2480* as *Juniperus deppeana*. The distal vegetative growth of *Cupressus arizonica* and the above taxa of *Juniperus* are nearly indistinguishable. This may reflect on the sister relationship between these genera (Brunsfeld et al. 1994; Gadek et al. 2000).

The putative occurrence of *Cupressus arizonica* in the Davis Mountains is of biogeographic importance, and we attempt to address the veracity of the recent report in Jeff Davis Co., Texas, through an alternative means. Cupressaceous taxa that are difficult to identify by conventional means have been accurately identified through chemical analysis (Gough & Welch 1978; Adams 1993; Hsiang & Huang 2000). In order to verify the determination of the two Davis Mountains putative *Cupressus arizonica* specimens, we have gathered and compared chloroplast DNA sequence data from these specimens and specimens of putative related taxa.

METHODS AND MATERIALS

The Davis Mountains specimens were compared to 4 individuals representing *Cupressus arizonica*, 2 other *Cupressus* species, 11 individuals of *Juniperus*, and 1 specimen each of the outgroups *Calocedrus*, *Chamaecyperis*, and *Thuja* (Table 1). This sampling was based on the generic relationships within Cupressaceae suggested by recent studies (Brunsfeld et al. 1994; Gadek et al. 2000). Specimens used for DNA sequencing were either collected during fieldwork in Mexico and the United States in 2001, previously vouchered herbarium specimens, or vouchered live plantings growing at Rancho Santa Ana Botanic Garden (RSABG).

For all specimens collected in 2001, DNA was extracted using 2X CTAB, followed by precipitation in cold isopropanol (Friar et al. 1996). One gram of terminal shoot tissue (including leaves) was used for these extractions. For specimens collected before 2001, a modified small prep for dried leaf tissue was used for extractions (Doyle & Doyle 1987). Amplification of cpDNA templates of the *trnL* intron and *trnL-trnF* intergenic spacer follows the methods outlined by Porter et al. (2000). Purified template amplifications were sequenced directly with four primers, *trnL*c, *trnL*d, *trnL*e, and *trnL*f (Taberlet et al. 1991), using "big

TABLE 1. Specimens used in molecular analysis.

Species	Location	Voucher
Calocedrus decurrens Torr.	CALIFORNIA. Los Angeles Co.:	*RSABG 13148* (RSA)
Chamaecyparis lawsoniana(A. Murr.) Parl.	CALIFORNIA. Del Norte Co.:	*RSABG 14672* (RSA)
Cupressus arizonica Greene	TEXAS. Brewster Co.:	*Bartel 571* (SRSC)
	TEXAS. Brewster Co.:	*Bartel 572* (SRSC)
	TEXAS. Brewster Co.:	*Warnock 7138* (SRSC)
	CALIFORNIA. San Diego Co.:	*RSABG 11746* (RSA)
cf *Cupressus arizonica* Greene	TEXAS. Jeff Davis Co.:	*Karges and Hedges 2480* (SRSC)
	TEXAS. Jeff Davis Co.:	*Karges s.n.* (SRSC)
Cupressus lindleyi Klotzsch ex Endl.	MEXICO. D.F.:	*Griffith 325* (RSA)
	MEXICO. Michoacan:	*Griffith 287* (RSA)
Cupressus macnabiana A.Murr.	CALIFORNIA. Shasta Co.:	*RSABG 11434* (RSA)
Juniperus coahuilensis (Martínez) Gaussen ex Adams	TEXAS. Brewster Co.:	*Bartel 575* (SRSC)
	TEXAS. Brewster Co.:	*Powell 5146* (SRSC)
Juniperus deppeana Steud.	MEXICO. Puebla:	*Griffith 324* (RSA)
	TEXAS. Jeff Davis Co.:	*Powell 5186* (SRSC)
	TEXAS. Jeff Davis Co.:	*Kolle 1193* (SRSC)
Juniperus flaccida Schlecht.	TEXAS. Brewster Co.:	*Bartel 574* (SRSC)
	MEXICO. Coahuila:	*Griffith 253* (RSA)
Juniperus jaliscana Martínez	MEXICO. Jalisco:	*Griffith 279* (RSA)
Juniperus monticola Martínez	MEXICO. Oaxaca:	*Griffith 304* (RSA)
Juniperus pinchottii Sudw.	TEXAS. Jeff Davis Co.:	*Keough 205* (RSA)
Juniperus virginiana L.	TEXAS. Bastrop Co.:	*Griffith 352* (RSA)
Thuja plicata Donn ex D. Don	CALIFORNIA. Humboldt Co.:	*RSABG 13452* (RSA)

dye" chemistry from Applied Biosystems Incorporated, according to the manufacturer's specifications. All sequences were gathered using an Applied Biosystems Incorporated 3100 automated DNA sequencer.

Chromatograms derived from sequencing were assembled into contigs, and edited using Sequencher v4.1 (Gene Codes Corporation, Inc.). Consensus sequences were manually aligned using Se-Al v2.0a72 (Rambaut 1996). The aligned DNA data matrix is available from the first author upon request. The phylogenetic relationships among these specimens were estimated using Fitch parsimony, in PAUP* v4.0ß8 (Swofford 1998). Estimations of confidence in the clades were obtained through bootstrap analysis (Felsenstein 1985) with 10,000 pseudoreplicates, and through jackknifing (Farris et al. 1996), also with 10,000 pseudoreplicates (63% deletion) as implemented in PAUP*.

RESULTS AND DISCUSSION

The specimens of *Cupressus arizonica* form a well-supported (94% bootstrap, 80% jackknife) monophyletic group with three other *Cupressus* specimens, and

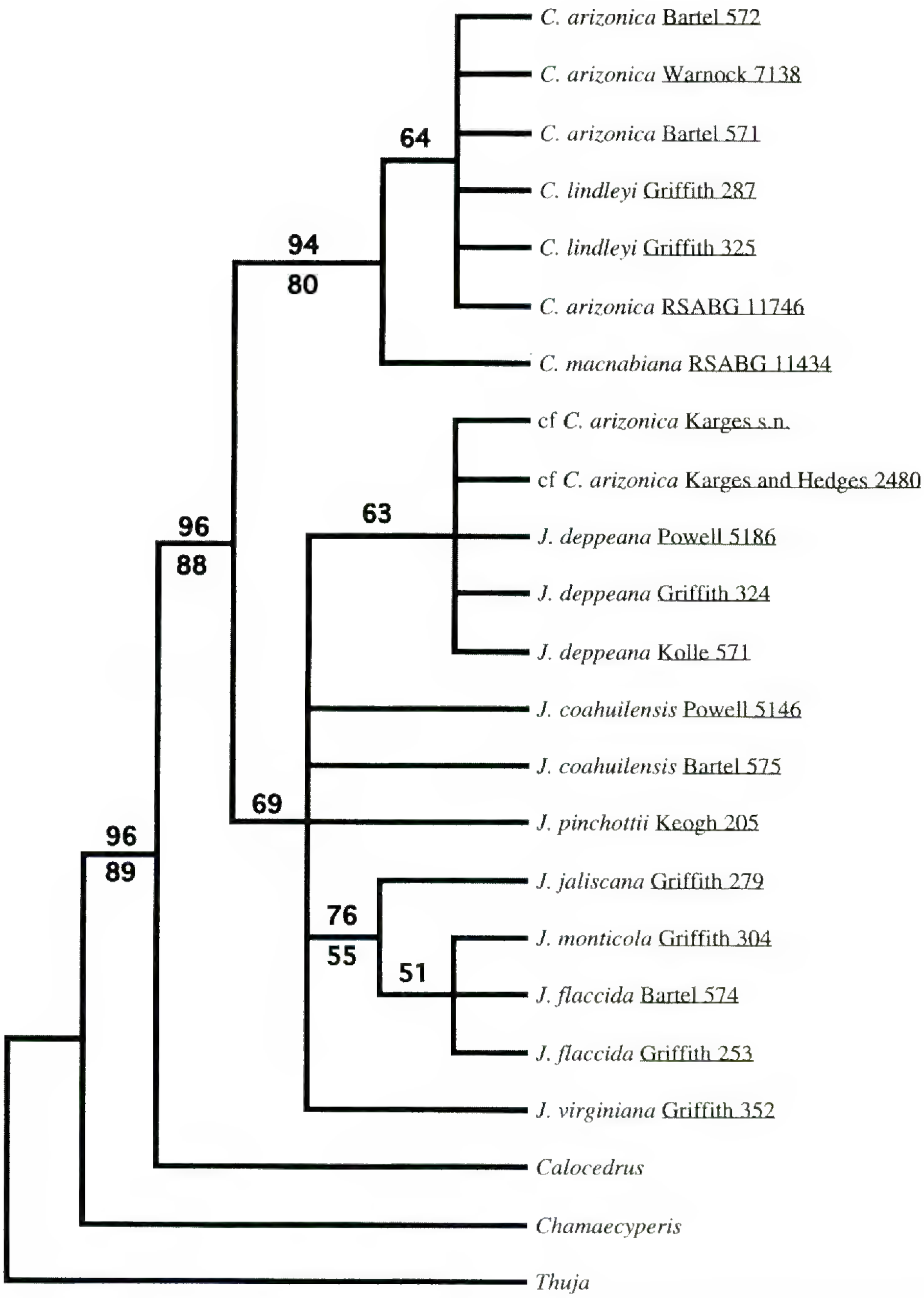


FIG. 1. A phylogenetic analysis of the two putative Davis Mountains *Cupressus arizonica* specimens (*Karges and Hedges 2480* and *Karges s.n.*) and related taxa. Strict consensus tree of 258240 most parsimonious trees from the branch and bound analysis of the *trnL-F* region. With uninformative characters excluded, length = 47; CI = 0.7660; RI = 0.8854; rescaled consistency = 0.6782. Bootstrap percentages above 50% are indicated above the branches, and jackknife support above 50% is indicated below the branches. *C.* = *Cupressus*, *J.* = *Juniperus*.

this clade excludes the two Bridge Gap putative *C. arizonica* specimens (Fig. 1). The three specimens of *Juniperus deppeana* plus the two Bridge Gap specimens form a clade, though lacking strong support (63% bootstrap). *Juniperus deppeana* is a species present at Bridge Gap (Karges & Zech 2001). In context with the known flora of the Davis Mountains, chloroplast DNA data clearly suggest that the two Bridge Gap specimens are not *Cupressus arizonica*, and are most likely *Juniperus deppeana*.

The first author examined the Bridge Gap cypress closely in July 1999 and made the following observations: The specimen's trunk bark is divided into rough squarish plates near the base, characteristic of *Juniperus deppeana* var. *deppeana* (Powell 1988). At a height of about 0.5 m, the gray-brown bark is separated into longitudinal ridges, a key character for *Juniperus deppeana* var. *sperryi* (Adams 1973; Powell 1988). In contrast, the inner bark of *Cupressus arizonica* is often described as reddish (Wolf & Wagener 1948; Powell 1998), maturing often into thin fibrous strips on large trees (Correll & Johnston 1979; Bartel 1993), although the bark of *Cupressus arizonica* sensu lato can be quite variable. Martínez (1963) notes that *J. deppeana* var. *patoniana* forma *obscura* may have the lower bark checkered and the upper bark furrowed.

Although other characters may be of use, in most taxonomic keys the major feature diagnostic between *Juniperus* and *Cupressus* is the presence of fleshy, fused cones (*Juniperus*), versus woody, dehiscent cones (*Cupressus*) (Correll & Johnston 1979; Powell 1988; Bartel 1993, Watson & Eckenwalder 1993). Of the two specimens of the Bridge Gap putative *Cupressus*, one (*Karges s.n.*) is devoid of reproductive features and the other (*Karges & Hedges 2480*) has three separate orbicular-spathulate scales that are 5–7 mm long and 6–8 mm wide. These scales appear to have been sessile at the proximal end rather than peltate. *Cupressus arizonica* has 4–5 partially peltate proximal pentagonal scales approximately 13–15 mm long, 12–14 mm wide, and 2–3(–4) distal oblong, truncate scales 5–8 mm wide and 9–11 mm long, completely peltate and valvate (Table 2). Morphologically, the scales present on *Karges & Hedges 2480* do not appear to be produced by *C. arizonica*.

One of the two putative *Cupressus arizonica* specimens (*Karges s.n.*) may be misdetermined because of a lack of reproductive characters, while the other (*Karges & Hedges 2480*) may have been determined as *C. arizonica* based on the three woody scales collected. Although the location of discovery of these three scales is faithfully recorded, we cannot be certain of their identity. Although unfortunate, this is not the first instance of a mixed collection being mistaken for something more significant (Thomson 1991). Given the above evidence, the present known distribution of *Cupressus arizonica* in Texas remains limited to the Chisos Mountains of southern Brewster County. This may change if a specimen exhibiting clear characters of *C. arizonica* is collected elsewhere in Texas.

TABLE 2. Specimens of *Cupressus arizonica* measured for morphological discussion.

Location	Voucher
California: San Diego Co.	*Everett 33264* (RSA)
Mexico: Sonora.	*Wolf 2564* (RSA)
Texas: Brewster Co.	*Bartel 571* (SRSC)
Texas: Brewster Co.	*Warnock 7138* (SRSC)

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DAHLIA NEGLECTA (ASTERACEAE: COREOPSIDEAE), A NEW SPECIES FROM SIERRA MADRE ORIENTAL, MEXICO

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ABSTRACT

Dahlia neglecta, a new species from the state of Hidalgo, Mexico, is described and illustrated. This species is distinguished by the combination of glaucous stems, tufts of light-colored hairs at the rachis nodes, strongly oblique blade bases, and mucronate ligules.

RESUMEN

Se describe e ilustrada *Dahlia neglecta*, una nueva especie del estado de Hidalgo, México. Esta especie se distingue por la combinación de tallos glaucos y un copete de pelos de colores suaves en los nudos del raquis. Además, las bases de las hojas pequeñas son dominantemente oblicuas, y con lígulas mucronadas. Se ofrece una clave del género.

While collecting material from wild populations of *Dahlia* to expand natural history information and for cytological and molecular analyses of the genus, several undescribed species from Mexico were encountered, one of which is described here.

Dahlia neglecta D.E. Saar, sp. nov. **(Fig. 1)**. TYPE: MEXICO. HIDALGO: ca. 7 km NE of Tulancingo, just below the first pass along Mex 130 to the gulf coast, zone of *Quercus* and arborescent *Opuntia*; SE-facing slopes, among rocks and recent road fill, sunny to mostly sunny locations, elev. 2320 m, 11 Sep 1995, *J.P. Hjerting, D.E. Saar, & P.D. Sørensen 95-86* (HOLOTYPE: MEXU; ISOTYPES: C, DEK, F, IEB, MO, TEX).

Herba perennis 1.1–1.5 m alti. Folia pinnata vel bipinnata. Multiflorus, capitula 10–12.5 cm diam., corollae radii ligulatae lavendulus, squammis exterioribus involucri reflexis sub anthesi. Distinguibilis a caules glaucedine, fasciculati densi ad rachis nodis, obliqus basis laminis, ligulae mucronatusque necnon.

Plants to 1.5 m (type locality) or 1.2 m (paratype population) with 1–3(–5) herbaceous stalks arising from perennial tuberous rootstock; internodes glaucous, hollow, nodes solid. **Median leaves** 19–24 cm long including petiole, bipinnate with stipels frequently at the second (occasionally second and third) rachis node, becoming pinnate without stipels to simple at the base of the flowering portion; petioles solid; rachis with prominent tufts of light-colored hairs at nodes, pinnules opposite on the rachilla, primary pinnae 5–7; leaflets dentate and ciliolate, blade bases strongly oblique, veins lighter-colored, sometimes creating a dusty appearance at first glance. **Capitula** to 12.5 cm in diameter including rays, borne on unbranched peduncles 6–19 cm long and projecting above

the foliage; outer involucral bracts reflexed at anthesis. **Ray florets** sterile; ligules lavender with a spot of yellow at the base, veins darker below, tips mucronate. **Disc florets** hermaphroditic, yellow. Cypselae elliptic-oblong, 8.6 mm wide × 1.2–1.6 mm long; black.

Etymology and distribution.—Flowering commences in August (in 1995). Plants from the type locality grow along and in full view of a busy highway (Mex 105) near the large city of Tulancingo. It is surprising, therefore, that this showy species has not been described previously, hence the specific epithet, *neglecta*. The known distribution for this species is presently limited to the holotype and paratype localities.

PARATYPE: MEXICO. HIDALGO: at K-8, 2 km SW of Mineral del Monte, along route Mex 105, zone of *Cupressus* and scattered shrubby *Quercus*; road cut with dense vegetation on SE-facing slope, elev. 2800 m, 11 Sep 1995, *J.P. Hjerting, D.E. Saar, & P.D. Sørensen* 95-97 (DEK, MEXU).

The combination of glaucous stems, tufts of light-colored hairs at the rachis nodes, strongly oblique blade bases, and mucronate ligules sets this species unmistakably apart from all others. Sørensen's (1969) key would place *Dahlia neglecta* in section *Dahlia*. Within the key for this section, *D. neglecta* pairs with *D. australis* and *D. sherffii* at couplet "N" (page 325) and incorporates some morphological characters from each species. *Dahlia neglecta* is similar to *D. australis* in that the lower leaf surfaces are conspicuously lighter green or silvery green, but the former differs by having flat (not revolute or obscurely so) margins, a smooth (not rugose) upper leaf surface and glaucous (not glabrous or pubescent) canes. The fruit is of similar length but only 1.2–1.6 mm wide versus 1.5–2.6 mm for *D. australis*. The smooth upper leaf surfaces of *D. neglecta* are similar to *D. sherffii*. *Dahlia neglecta* differs from *D. sherffii* by its glaucous (not glabrous) canes, bicolored leaf surfaces, and narrower fruit (*D. sherffii* = 2.2–3 mm). The unique combination of characters mentioned earlier also distinguishes *D. neglecta*. None of these species are sympatric in their distributions.

A molecular study of the genus which utilizes combined molecular sequences from the internal and external transcribed spacer regions (ITS and ETS, respectively) of nuclear ribosomal DNA, shows good support (86% bootstrap value) for placing *Dahlia neglecta* in a pectinate clade ("Variable Root Clade") that includes the "tree dahlias" (sect. *Pseudodendron*: *D. imperialis*, *D. excelsa*, and *D. tenuicaulis*), sect. *Epiphytum* (*D. macdougallii*), two species from sect. *Dahlia* (*D. rudis* and *D. apiculata*), and an unpublished species (Saar et al. in press). Within this clade, *D. neglecta* is most closely allied with *D. apiculata* and *D. tenuicaulis*, but support is minimal (57% bootstrap value). *Dahlia neglecta* is not sympatric with these species and both *D. apiculata* and *D. tenuicaulis* have lignified perennial canes, whereas *D. neglecta* is herbaceous.

The description of *Dahlia neglecta* brings the number of "wild" or naturally-occurring species of *Dahlia* to 35, but does not include the cultivated forms

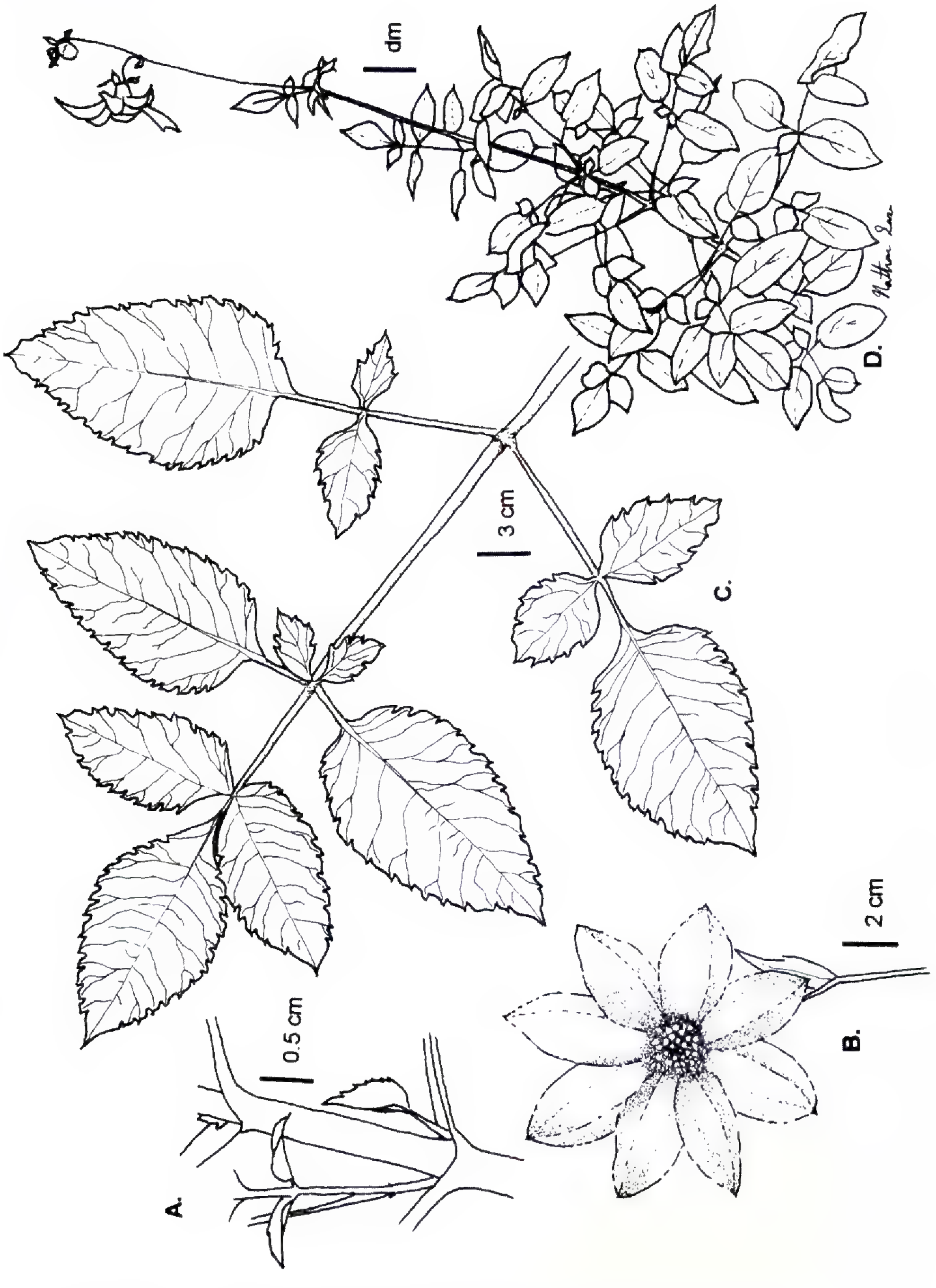


FIG. 1. *Dahlia neglecta*: **A.** leaf bases; **B.** flowering head; **C.** median leaf; **D.** general habit. Drawn from type specimens and photographs.

often called *D. variabilis* or occasionally *D. pinnata* (see Hansen & Hjerting 1996 for clarification of the latter Latin binomial). This total does, however, include three previously undescribed species currently "in review" or "in press:" *D. hjertingii* (Hansen and Sorensen in press), *D. campanulata*, and *D. cuspidata*.

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THE VARIETIES OF *LIATRIS ELEGANS* (ASTERACEAE)

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ABSTRACT

A description of two new infraspecific taxa in *Liatris elegans* is presented. ***Liatris elegans*** var. ***bridgesii***, var. nov., occurs on the Carrizo and adjacent Eocene sand formations in central Texas. ***Liatris elegans*** var. ***kralii***, var. nov., occurs on the Fall Line Sandhills and coastal plain of Alabama and Georgia to the northern panhandle of Florida. The newly described taxa are similar to each other in their cream-white to yellow (vs. anthocyanin-colored) phyllary apices but they are widely separated geographically and each is distinct in other morphological features; they are viewed here as having independent origins. *Liatris elegans* var. *flabellata* is reduced to a form of *L. elegans* var. *elegans*, while *Liatris elegans* var. *carrizana* is maintained for southern-central Texas populations. *Liatris elegans* var. *elegans* is widespread on the coastal plain from South Carolina to eastern Texas.

KEY WORDS: Liatris, Asteraceae, Texas

RESUMEN

Se presenta la descripción de dos nuevos taxa infraspecíficos en *Liatris elegans*. ***Liatris elegans*** var. ***bridgesii***, var. nov., se da en el Carrizo y formaciones arenosas adyacentes del Eoceno en el centro de Texas. ***Liatris elegans*** var. ***kralii***, var. nov., aparece en la Fall Line Sandhills y llanura costera de Alabama y Georgia hasta el estrecho de Florida. Los nuevos taxa descritos se parecen entre si por sus ápices de los filarios de blanco-crema a amarillo (vs. color de antociano) pero están ampliamente separados geográficamente y se diferencian por otras características morfológicas; Se ven aquí con dos orígenes independientes. *Liatris elegans* var. *flabellata* se ha reducido a una forma de *L. elegans* var. *elegans*, mientras que *Liatris elegans* var. *carrizana* se mantiene para las poblaciones del sur-centro de Texas. *Liatris elegans* var. *elegans* es común en la llanura costera desde Carolina del Sur al este de Texas.

Liatris elegans Michx. is an obligate psammophile, occurring in well-drained, loose to somewhat compacted sandy soils in open to sparsely forested habitats across much of the Gulf and Atlantic coastal plains and in the southern Interior Highlands province in Arkansas. Its colored, elongated, conspicuous phyllary apices in combination with white to yellowish-cream corollas distinguish it as one of the most recognizable species in the genus (cf. King & Robinson 1987). All other species have more or less herbaceous, relatively short, inconspicuous phyllaries with exserted, lavender to pink corollas (Gaiser 1946). Thus, in *L. elegans* the phyllaries rather than the flowers provide primary visible coloration of the columnar inflorescences. Throughout most of the range of *L. elegans* (herein, *L. elegans* var. *elegans* and *L. elegans* var. *carrizana* L.O. Gaiser) populations have phyllaries that are predominantly shades of lavender, pink, bluish, or magenta, colors that are presumably generated by anthocyanin

pigments. Two sets of populations, one on the western margin of the range in Texas, another in the eastern Gulf Coastal Plain in Alabama, Georgia, and Florida, mostly lack classic anthocyanin coloration at anthesis. Instead, these have primarily yellowish, cream, or nearly white phyllaries with some populations variably cream to faintly lavender. The Texas populations were discussed briefly by Gaiser (1946, p. 174, as *L. elegans* forma *fisheri* Steyermark), but accurate description of the variation is lacking. In addition, the well-defined pattern of distribution of the eastern coastal plain pale-phyllaried populations has never been addressed. While phyllary color alone may not be taken as a reliable indicator of genetic cohesion, the geographic integrity and populational uniformity of these unique populations suggests that selection for phyllary color has taken place within these populations. A recognizable suite of other morphological features supports their recognition but the presence of intergradation of both sets of populations with var. *elegans* further suggests that recognition at an infraspecific rather than specific rank is warranted. I have chosen variety to indicate that intermediate populations occur along the margins of these novel taxa.

Liatris elegans Michx. var. **bridgesii** Mayfield, var. nov. (**Fig. 1**). TYPE: U.S.A. TEXAS. MILAM CO.: 2.6 mi W of [FM 487 in] Rockdale on US 79; S side of railroad track, Simsboro Sand Formation, 505 ft, N 30°38'34" W 97°02'52", 6 Sep 1992, *Mark H. Mayfield 1549* (HOLOTYPE: TEX; ISOTYPES: F, FLAS, GA, GH, MO, NCU, NY, US).

Liatris elegans forma *fisheri* Steyermark, Field Mus. Nat. Hist., Bot. Ser. 11: 275. 1936. TYPE: TEXAS: CORYELL CO.: near and on the highway, 4 mi S of Copperas Cove, 26 Aug 1934, *George L. Fisher s.n.* (HOLOTYPE: F #761244!).

Differt a *L. eleganti* var. *eleganti* apicibus phyllariis petaloideis flavis aut eburneis vel pallide roseis aut lavandulis; differt a *L. eleganti* var. *kralii* apicibus phyllariis valde recurvatis ac capitulis coacervatis patentibus plerumque sessilibus.

Corms globose; stems sparsely to densely tomentose; lateral heads usually densely crowded, divergent-ascending to spreading at right angles, sessile; phyllaries parallel and appressed below the petaloid portion, the colored apices recurved, abaxially pubescent to tomentose, initially pale lemon yellow, then fading to cream or very pale lavender, rarely rosescent at fruiting; corollas cream-white, tubular, the tube scarcely broadened to the top of the limb, the lobes scarcely flared apically; stigmas cream to light yellow or nearly white.

PARATYPES: **U.S.A. TEXAS**. **Anderson Co.:** George Engling Wildife Management Area, Upper North Pasture, W Side, 1954 Burn, 18 Sep 1958, *Marsh 55-8* (TEX). **Bastrop Co.:** 1.8 mi SE of McDade along old highway by railroad track, 30 Jul 1992, *Mayfield & Westlund 1486* (NCU, NY, TEX). **Freestone Co.:** FM 1848, 5.8 mi N of Buffalo at jct. US 79, lower Queen City formation, N 31°32'46" W 96°03'22", 6 Sep 1992, *Mayfield 1557* (F, FLAS, GA, GH, NCU, NY, TEX, US); 14 mi S of Fairfield, 15 Aug 1955, *Turner 3904* (BRIT,TEX). **Grimes Co.:** along main highway E of Brazos county line, 4 Sep 1993, *Mayfield et al. 1779* (TEX). **Hardin Co.:** 2.5 mi W of Silsbee, 2 Oct 1945, *Cory 49880* (BRIT). **Henderson Co.:** 8 mi NW of Poynor, grassy open oak woods in sandy soil, flowers whitish, 20 Oct 1963, *Correll 28558* (LL).





FIG. 1. *Liatris elegans* var. *bridgesii*. **A.** Habit. **B.** Close-up of heads showing yellow to cream phyllary apices.



FIG. 3. *Liatris elegans* var. *carrizana* with consistently colored blue, magenta, lavender, or pink, rather than cream phyllaries.



FIG. 2. *Liatris elegans* var. *elegans* with phyllaries that are predominantly shades of lavender, pink, bluish, or magenta.



FIG. 4. *Liatris elegans* var. *kralii*.

Houston Co.: Davy Crockett N. Forest, N of SR 7 from a point 2.6 mi W of the junction of FM 357 and 0.9 mi E of FM 1733, 21 Sep 1991, *Mayfield et al. 1123* (NCU, NY, TEX); 2 mi S of Grapeland, 12 Oct 1937, *Cory 26136* (F). **Lee Co.:** NW of Lexington, on county road to Phears Cemetary, by small pond, Carrizo formation, 500 ft, N 30°27'30" W 97°03'15", 15 Sep 1991, *Mayfield et al. 1117* (GH, NCU, NY, TEX). **Leon Co.:** 5 mi NE of Buffalo along hwy 79, 11 Sep 1958, *Turner 4433* (TEX). **Limestone Co.:** 5.5 mi E of Kosse, 9 Oct 1964, *Shinners 30579* (BRIT). **Nacogdoches Co.:** 4 mi W by N of Garrison, 7 Sep 1948, *Cory 54734* (LL). **Robertson Co.:** county road 330 ca 2.0 mi E of its junction with FM 2246, 500 ft, N 31°01'34" W 96°21'59", 6 Sep 1992, *Mayfield 1559* (GH, NCU, NY, TEX). **San Augustine Co.:** sandy open forest ca. 1.5 mi N of San Augustine, flowers whitish, 14 Oct 1962, *Correll 26282* (LL). **Shelby Co.:** ca. 0.8 mi SE of SR 7 on a parallel unpaved road, ca 0.1 mi W of a small lake on Upper Iron Ore Cr, 1.2 mi E of Mt Hermon, 21 Sep 1991, *Mayfield et al. 1130* (NCU, NY, TEX). **Van Zandt Co.:** Ca. 1.5 mi NW of Ben Wheeler on SR 64, 0.2 mi S of SR 64 opposite a cemetary on the N side of the road, 22 Sep 1991, *Mayfield et al. 1138* (F, GH, NCU, NY, TEX). **Walker Co.:** ca. 3 blocks E of Sam Houston St Un, 27 Sep 1980, *Kessler 3679* (FLAS). **Williamson Co.:** 0.7 road mi N of FM 112 on county road, ca 0.8 mi W of Milam Co. line and 9 mi S of Thorndale, Simsboro Formation, 530 ft, 30°29'24" N, W 97°10'40", 15 Sep 1991, *Mayfield et al. 1120* (F, GH, NCU, NY, TEX). **Wood Co.:** Lake Ellis, 5 mi NE of Crow, 2 Sep 1942. *Lundell 11730* (LL).

Forma as a category fails to represent the clear geographic pattern that occurs in var. *bridgesii*. I have chosen to provide a novel epithet for the present taxon because the type locality of forma *fisheri* is apparently inaccurate. No populations of *L. elegans* var. elegans (Fig. 2) occur anywhere close to the designated location "on the highway 4 miles south of Copperas Cove" in Coryell County. While there are some thin, Cretaceous sand-bearing strata in this area as well as some river terrace sands, searches around Copperas Cove have not yielded populations or habitat suitable for *L. elegans*. Furthermore, no other collections from the area were located in searches of three major herbaria in central Texas, among others. The establishment of a new type and name will serve to solidify the concept of the taxon.

Etymology.—This variety is named for Edwin L. Bridges, prolific plant collector and knowledgeable floristician/taxonomist. Bridges' tenacity in the field and his incredible plant recognition skills are truly inspiring. Our memorable field trips into the sand-bearing strata east of Austin, Texas, were crucial to my understanding of this and many other sand-loving species.

Distribution, variation and ecology.—Liatris elegans var. *bridgesii* is best represented in the southwesternmost part of its range from north of the Colorado River in Bastrop and Lee Counties northeast to Henderson County in Texas. Here, populations consist entirely of individuals with phyllaries that are creamy white to very pale lavender, and possess long-tubed corollas with relatively short weakly flared lobes. In the Post Oak savannas of Williamson, Milam, Lee, and Robertson counties, all populations I found had consistently cream-colored phyllaries. The latter begin the flowering season with a very striking, nearly lemon yellow color in the phyllaries, a color that is otherwise not present in the phyllaries of any Liatrinae. Later in the season, well into fruiting, the color fades to creamy white, sometimes infused with a rose or lavender tinting. Further

northeast, populations seem to intergrade in terms of phyllary color but other features are consistently more like var. *bridgesii* than var. *elegans*. The phyllaries of var. *bridgesii* tend to be longer and more strongly recurved with longer, more narrowly tubular, pale cream corollas than in var. *elegans*. The var. *bridgesii* is similar to the next newly described variety in the pale coloration of the phyllaries, but it has a more compact inflorescence with more strongly recurving phyllary tips and sessile heads (see further discussion below regarding pedunculate heads).

The var. *bridgesii* occurs almost exclusively on Eocene sand-bearing strata running from southwest to northwest from the north side of the Colorado River in Bastrop County to Wood County in the northeast. Its influence is also apparent in population eastward through Cherokee and Houston, to Nacogdoches, Shelby, and San Augustine Counties where the Carrizo formation is exposed around the western margin of the Sabine uplift. Post-oak savanna is the primary habitat where this variety is found. Mixed pine forests of eastern Texas are more likely to have populations of *L. elegans* var. *elegans* (Fig. 2) but both occur therein and some intergradation is observed.

Liatris elegans var. **carrizana** L.O. Gaiser (**Fig. 3**) occurs south of the Colorado River in Texas on deep, sandy soils of xeric sandhills (cf. Gaiser 1946). This variety is characterized by its elongated, napiform corm suited to the drier climate and deep sands that prevail in this region. Its phyllaries are structurally similar to those of the var. *bridgesii*, with elongated strongly recurving apices, but they are consistently colored blue, magenta, lavender, or pink, rather than cream. Populations of var. *carrizana* just to the south of the Colorado River in Bastrop and Caldwell Counties, Texas, may have more or less globular corms but are otherwise more similar to the var. *carizzana*. In all other areas, *L. elegans* has depressed globose corms as is true of many species of the genus.

Liatris elegans Michx. var. **kralii** Mayfield, var. nov. (**Fig. 4**).TYPE: U.S.A. ALABAMA. LEE CO.: Locally abundant in open pine woods 6 mi S of Auburn, 23 Sep 1899, *F.S. Earle and E.S. Earle 94* (HOLOTYPE: KSC!; ISOTYPES: F! GH! ND NY! US).

Similis a *L. eleganti* var. *bridgesii* apicibus phyllariis flavis aut albis vel pallide lavandulis sed capitulis ascendentibus pedunculatis magis interruptis et phyllariis divergentibus (vs. appressis) infra partem petaloideum ac leniter recurvatis ad apices

Corms globose; stems sparsely to densely lanose-tomentose; lateral heads (at anthesis) usually loosely arranged, ascending to divergent, pedunculate; phyllaries abaxially tomentose to densely lanose, divergent along their length, the petaloid apices flaring only slightly or not at all, initially light yellow or cream, then fading to cream; less often pale lavender to rose, corollas pure-white, tubular, the tube flaring gradually to the top of the limb, the lobes strongly flared; stigmas white to very pale lavender.

PARATYPES: **U.S.A. ALABAMA. Baldwin Co.:** Gateswood, 30 Oct 1903, *Tracy 8568* (F,GH). **Barbour Co.:**

6.4 mi N of the Barbour/Dale County line along Alabama route 51, ca. 4.5 mi N of Doster, Turkey Oak/Bluejack Oak/Hickory sandhill area, 495 ft, 31°40'55" N, 85°38'10" W, 12 Aug 1994, *Mayfield & Fuertes 2011* (TEX). **Covington Co.:** Dozier, 31 Oct 1941, *Reed 2053* (TEX). **Escambia Co.:** dry, sandy area above low hillside seepage bog under powerline, on N side of western extension of Co Rd 6, 2.4 mi W of Co Rd 27 and 2.6 mi W of AL 113 at a point 3.8 mi N of int US 31 E of Flomaton, just W of Pond Cr, SH SWQ SEQ of sec 1, T1N R7E, Flomaton 7.5' quad, Soils-Plummer (Grossarenic paleaquults), elev 130 ft, 31°04'14" N, 87°19'01" W, 11 Sep 1989, *Orzell and Bridges 11815* (TEX); 3 mi s of Canoe, 17 Oct 1929, *O'Neill 6171* (FLAS). **Geneva Co.:** Sandy west banks of Choctawhatchee River between Geneva and Eunola by Al 52, 18 Sep 1971, *Kral 44342* (NY). **Lee Co.:** 2.1 mi NW of Phenix City, 17 Sep 1971, *Kral 44247* (NY). **Mobile Co.:** USA Property, 17 Oct 1968, *Lelong 4879* (NCU). **Russell Co.:** 1 mi SE of Glenville, 26 Sep 1976, *Haynes 6021* (NCU). **FLORIDA. Okaloosa Co.:** Crestview, 29 Sep 1946, *Knight s.n.* (NCU). **Santa Rosa Co.:** pine woods on Juniper Creek, Rd. 4, 6 Oct 1949, *Hood 3226* (FLAS). **Washington Co.:** vicinity of Falling Waters Sink, longleaf pine deciduous scrub oak forest, 17 Sep 1956, *Kral 3574* (GH). **GEORGIA. Ben Hill Co.:** 7 mi NNW of Fitzgerald, 26 Oct 1968, *Faircloth 5691* (NCU). **Coffee Co.:** 7.2 mi E of ridge on outcrop of Altamaha Grit, 17 Oct 1970, *Faircloth 6936* (NCU). **Grady Co.:** Sandy clay ridge, open, 2 mi W of Wigham, 26 Oct 1963, *Godfrey 63218* (LL). **Macon Co.:** Near Marshallville, 28 Sep 1926, *Dunegan 15* (LL). **Meriwether Co.:** Warm Springs, 1 Oct 1945, *Totten et al. s.n.* (NCU). **Muscogee Co.:** Columbus, 17 Sep 1902, *Biltmore Herbarium* [no further collector information on label] (NY). **Taylor Co.:** Sandy scrub oak habitat of deep sands of Fall Line Sand Hills, ca. 1 mi NNE of Charing and 11-12 mi SW of Butler on GA 137, 10 Sep 1974, *Jones* et al. *22598* (NCU); 3.8–4.0 mi N of Butler on high wand ridge along HWY 19, xeric longleaf pine/turkey oak sandhill woodland, Fall-Line Sandhills, 570 ft, 32°36'34" N, 84°14'15" W, 11 Aug 1994, *Mayfield & Fuertes 1998* (TEX).

Etymology.—This variety is named to honor Dr. Robert R. Kral, well known as one of the most knowledgeable botanists on the southeastern US flora. Kral's personal collections amassed over four decades from the coastal plain have contributed greatly to the understanding of this and many other species. His classes I took as an undergraduate in Plant Taxonomy and Dendrology stimulated my interest in botany.

Distribution, variation, and ecology.—*Liatris elegans* var. *kralii* occurs in two major population centers. Populations to the north, in the Fall-Line Sandhills of western-central Georgia to eastern-central Alabama, including the type, consistently bear phyllary apices that are white to light tan in color. A second, somewhat separated area of occurrence is further to the south in counties along the southern tier of Georgia, northern tier of Florida, and west to Mobile County in Alabama. In this area scattered populations of var. *kralii* occur sympatrically (but not apparently in mixed populations) with var. *elegans*. The var. *elegans* is much more common in this area but relatively pure populations of var. *kralii* do occur, albeit usually with both white and pale lavender forms (e.g., *Kral 37333*, Mobile Co., AL; *Kral 44342*, Geneva Co., AL; *Faircloth 5691*, Ben Hill Co., GA; *Kral 3574*, Washington Co., FL). All populations referable to var. *kralii* have short peduncles bearing the heads and the heads are well-spaced and ascending. Although pedunculate heads may otherwise occur throughout the range of the species in shaded or apically injured plants, these are rare and unusual. Also, the phyllaries of var. *kralii* are longer and narrower, with the petaloid portion especially elongate in proportion to the basal herba-

ceous portion. Another recognizable trait of var. *kralii* is the divergent phyllaries with the tips ascending, rather than recurved. All other varieties have more strongly recurved phyllary apices, with the lower herbaceous portions closely appressed.

Variety *flabellata*.—The type specimen of var. *flabellata* apparently consists of a single plant divided into two separate sheets. The only two sheets referable to this taxon are at NY; one has a single plant with root and two stems attached and a third stem severed at the base. The second sheet is a single stem that appears to have come from the severed base of the plant on the other sheet. The only feature separating this plant from var. *elegans* is its emarginate to truncate, relatively broadened (flabellate) phyllary apices. From the same locality (St. Helena Island, S.C.) numerous other specimens collected by Cuthbert at NY and FLAS have phyllary morphology as is typical for the var. *elegans*. Thus, I view the type specimen as consisting of a single plant from a locality with plants otherwise identical to the var. *elegans*. Thus it is best treated as an aberrant or freak, admittedly distinctive, but not persisting as a viable population. It is reduced here to a form of var. *elegans*.

Liatris elegans Michx. var. **elegans** forma **flabellata** (Small) Mayfield, comb. nov.
Laciniaria flabellata Small, Bull. Torrey Bot. Club 25:472. 1898. *Liatris flabellata* (Small) K. Schum., Just's Bot. Jahresber. 26:378. 1900. *Liatris elegans* (Walter) Michx, var. *flabellata* (Small) Gaiser, Rhodora 48:345. 1946. TYPE: SOUTH CAROLINA. BEAUFORT CO.: St. Helena Island, dry barrens, Sept 1894, *A. Cuthbert s.n.* (HOLOTYPE: NY!; ISOTYPE: NY!).

ACKNOWLEDGMENTS

The curators of herbaria cited are acknowledged for loaning specimens and the many field trips were in part supported by my graduate institution-Plant Resources Center, Dept. of Botany, at the University of Texas at Austin. Thanks are also due to my several field companions who so graciously gave their time to allow me to collect *Liatris elegans*. Guy Nesom greatly improved an earlier draft of the manuscript and provided the Latin translations for the diagnoses.

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Book Review

Ronald A. Coleman. 2002. **The Wild Orchids of Arizona and New Mexico.** (ISBN 0-8014-3950-7, hbk.) Cornell University Press. Sage House, 512 E. State Street, Ithaca, NY 14850. (Orders: www.cornellpress.cornell.edu). $39.95, 272 pp, 35 line drawings, 36 maps, 160 color plates, 6" × 9 1/4".

This volume is just one of many regional orchid floras published for North America within the last 15 years. Though the *Native Orchids of the United States and Canada* was published in 1975 by Carlyle Luer, regional floras, such as this one, update nomenclature and more clearly define geographic ranges. Since Orchidaceae is one of the largest flowering plant families, has a cosmopolitan distribution, and occupies many diverse habitats, small regional floras, like this one, provide a baseline of knowledge. Coleman presents to his readers a rather varied orchid flora in Arizona and New Mexico, composed of 35 species and 14 genera. The most diverse region in both states for spotting orchids is the Mogollon Rim. The combination of high elevation and precipitation provides habitat for orchids, in comparison to the rest of the two states where desert or high plains dominate. For those interested in collecting orchids, you might think twice. All of the orchids of Arizona and a few in New Mexico are protected by law, so all you should take away from your orchid-hunting adventures are photographs and memories.

The book begins with a lucid discussion of floral morphology, habitats and geographic distribution in Arizona and New Mexico, as well as information on blooming seasons and conservation. Next, a key to orchid genera is provided and could not be more straightforward. The terminology is basic and would be useful to anyone, even those with only a basic understanding of botanical terminology. Following the introduction are genera and species descriptions. Genera and species are listed in alphabetical order. For each genus, the author provides a citation of effective publication, etymology and a rather informal description or discussion of the group. For example, in the discussion on *Cypripedium*, the reader learns that the lip of the flower serves as a trap to the pollinator, who once inside finds it hard to escape. Moreover, the discussion on *Corallorhiza* helps enthusiasts clearly distinguish the members of this genus from those of *Hexalectris*. If there is more than one species present, a key is provided. Following the generic discussions are species descriptions, which also include a citation of publication and etymology of the epithet. In addition, synonymy, a short non-technical description, distribution, habitat, blooming season, conservation issues and threats to each species are included. Because the author has taken an informal approach to describing each species, it becomes much more interesting to the reader. A case in point is the interesting story on nomenclature of *Schiedeella arizonica* and how misapplied names can lead to taxonomic confusion. In the margin next to each species description is a line drawing of the flower. These illustrations provide a practical identification tool. A dot map for each species shows presence of that species in Arizona and New Mexico counties.

Several appendices conclude the book: 1) Excluded species, 2) Watch list of species not yet reported from Arizona or New Mexico, 3) Herbarium collections studied, and 4) Distribution of orchids in Arizona and New Mexico listed by county. Color photographs seem strategically placed at the beginning of the book, where they can whet the reader's appetite. Most of the photos are close-ups of flowers or fruits, but also include examples of plants in habitat.

This is a wonderful publication on orchids packed with an abundance of information useful to anyone with any affinity to orchids. Coleman's writing style is clear, concise, and unpretentious. It would make a lovely addition to the library of a native plant lover, botanist, or orchid enthusiast.—*Amy Trauth Nare, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX, 76102 U.S.A., amy_trauth@yahoo.com.*

DOCUMENTED CHROMOSOME NUMBERS 2002:3. CHROMOSOME COUNTS FOR *PACKERA PAUPERCULA* VAR. *APPALACHIANA* (ASTERACEAE: SENECIONEAE)

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ABSTRACT

Certain populations of more or less tomentose *Packera* (Asteraceae: Senecioneae) in southeastern North America have recently been treated as *P. paupercula* var. *appalachiana* based on evidence from a common garden, canonical discriminate analyses of morphological characters and flowering date, a preliminary RAPDs analysis, and crosses. Previously they had been treated as disjuncts of *P. plattensis*, a species of the Great Plains, which may have migrated into the mid Appalachians during the post-glacial Hypsithermic Period and survived there as relicts. However, *P. plattensis* is tetraploid with $n = 46$ and $x = 23$. Our two chromosome counts of the new variety from North Carolina and from Virginia are $n = 22$ and $n =$ ca. 44, respectively, a diploid and a tetraploid, both with $x = 22$. Statistical analyses of pollen diameter provide evidence that the other individuals in the two populations are diploid and mostly tetraploid, respectively. Hybridization with *P. aurea* may be involved in the origin of the tetraploid. Thus, cytological evidence supports other data showing that these populations may be more closely related to *P. paupercula*.

RESUMEN

Ciertas poblaciones de *Packera* (Asteraceae: Senecioneae) más o menos tomentosas del sureste de Norte América han sido tratadas recientemente como *P. paupercula* var. *appalachiana* basándose en evidencias procedentes de un jardín común, análisis canónico discriminante de caracteres morfológicos y datos florales, un análisis preliminar de RAPDs, y cruces. Previamente habían sido tratados como disyuntas de *P. plattensis*, una especie de las Grandes Llanuras, que podría haber migrado a los Apalaches medios durante el periodo hipsitérmico post-glacial y sobrevivido allí como relicto. Sin embargo, *P. plattensis* es tetraploide con $n = 46$ y $x = 23$. Nuestros dos recuentos cromosomáticos de la nueva variedad de Carolina del Norte y de Virginia son $n = 22$ y $n =$ ca. 44, respectivamente, un diploide y un tetraploide, ambos con $x = 22$. Los análisis estadísticos del diámetro del polen evidencian que los otros individuos de las dos poblaciones son diploides, y preferentemente tetraploides, respectivamente. La hibridación con *P. aurea* puede ser la causa del origen del tetraploide. Así, la evidencia citológica apoya otros datos que muestran que estas poblaciones pueden estar más emparentadas con *P. paupercula*.

INTRODUCTION

Packera plattensis (Nutt.) Weber and Á Löve is distributed in dry grasslands from the eastern flanks of the southern Rocky Mountains to the Mississippi

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River with scattered populations eastward in Wisconsin and Missouri (Barkley 1962, 1978) (Fig. 1). It is tetraploid with a base chromosome number of $x = 23$ (Kowal 1975; Kowal et al. unpubl. ms.).

Apparently disjunct populations occur in Pennsylvania, Virginia, Tennessee, North Carolina and South Carolina (Barkley1962, 1978, 1988; Uttal 1982; Rhoads & Klein 1993) (Fig. 1). Barkley hypothesized that these are remnants of the widespread eastern migration of prairie-adapted plants during the Hypsithermic Period of about 8000 years ago. Such populations in Montgomery Co., Virginia commonly hybridize with *P. aurea*, *P. anonyma*, and *P. obovata* (Uttal 1982). Because the latter three species are usually diploid with $x = 22$ (Kowal et al. unpubl. ms.), widespread hybridization with *P. plattensis* would be unexpected (Mahoney & Kowal ms. subm.; Kowal et al. unpubl. ms.). Moreover, herbarium specimens from the entire range of the eastern disjunct populations are morphologically different from *P. plattensis* of the Great Plains in their rosette and cauline leaves and in their smaller heads.

Individuals from North Carolinian and Virginian populations of putative *P. plattensis* were included in a larger study of the *P. paupercula* complex and allied species (Mahoney & Kowal ms. subm.). Replicates were grown in a standard environment transplant garden, and data on morphology and flowering time were analyzed by canonical discriminant analyses (CDA) and analyses of variance (ANOVA). Herbarium specimens of the complex, emphasizing its distribution east of the Mississippi River, were studied, and a preliminary analysis of genetic similarity using random amplified polymorphic DNAs (RAPDs) was made. One conclusion is that these central Appalachian populations are best included in the polymorphic *P. paupercula* complex as *P. paupercula* var. *appalachiana* A.M. Mahoney var nov. ined. Chromosome numbers provide critical evidence supporting this conclusion.

MATERIALS AND METHODS

Individuals of putative eastern disjunct *Packera plattensis* (*P. paupercula* var. *appalachiana)* were collected from two sites. The Paint Rock Road population (NC, Madison Co.: near Hot Springs, 3.2 mi northwest along Paint Rock Road from Hwy 25-70, *Kowal & Mahoney 3120* [WIS]) grows in loose, gravelly soil on a steep, wooded, southwest-facing slope and road cut overlooking the French Broad River. The Lover's Leap population (VA, Montgomery Co.: 2 mi west from Price's Fork on McCoy Road [rt. 652], *Kowal & Mahoney 3123* [WIS]) consists of scattered clones on exposed and wooded rocky outcrops on a south-facing bluff overlooking the New River and along the south side of McCoy road on a gravelly bank. Replicated individuals were randomly positioned in a standard-environment transplant garden in Madison, WI.

Heads from test garden individuals were fixed in Jackson's solution (4 ethanol: 2 methanol: 2 chloroform: 1 propionic acid: 1 acetone, v/v), transferred

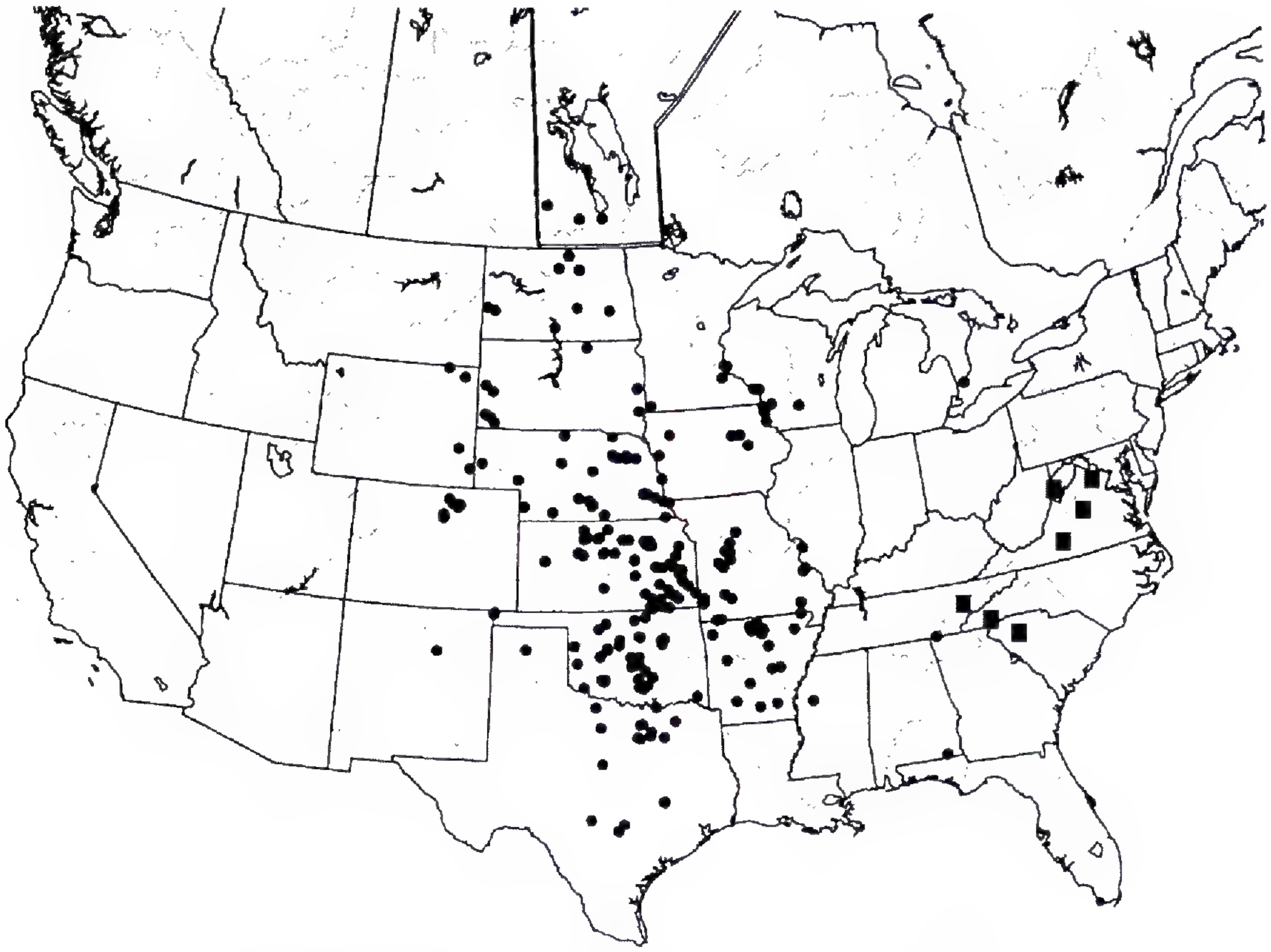


FIG. 1. Distribution of *Packera plattensis* and hypothesized disjunct populations in Virginia, North Carolina, and South Carolina (*P. paupercula* var. *appalachiana*). ● *P. plattensis*; ■ Disjunct populations (*P. paupercula* var. *appalachiana*).

after about a day to 70% ethanol, and stored in a freezer. Counts were made on meiocytes of young anthers from florets 2.5-3.0 mm in length. Using a squash technique, described in Beeks (1955) as modified by Kowal (1975) and Kong (1998), anthers were prestained in aceto-carmine and squashed between a slide and a cover slip. Each slide was scanned under the 40 × objective of a Zeiss Standard WL phase-contrast microscope, and cells with promising meiotic figures were resquashed until their chromosomes were well-separated and in one plane. Coverslips were sealed with "Zut." Counts were made with the 100 × objective under oil immersion, and cells with well-separated chromosomes were photographed with Kodak Ektachrome 160 and Technical Pan (exposed at an ASA of 100) films using a Nikon Microflex Model AFM photomicrographic attachment (Kong 1998). Results are in Table 1 and substantiating photographs are in Figures 2 and 3.

RESULTS

Individual 9 from Paint Rock Road (NC, Madison Co.) is diploid with $n = 22$ (Kong 1998; Figs. 2 & 3). Individual 9 from Lover's Leap (VA, Montgomery Co.)

TABLE 1. Chromosome counts for *Packera paupercula* var. *appalachiana*.

Taxon	Haploid number	Cells counted	Phase
NC, Paint Rock Rd, #9	22	34	Metaphase I & II
VA, Lover's Leap, #9	44	1	Anaphase I

is tetraploid with $n = 44$, based on a single, but fairly good preparation (Figs. 4 & 5). A poor anaphase I from individual 10 from Lover's Leap gave an extremely rough count of $2n$ = ca. 67, superficially, an approximately triploid count. However, the regular meioses, terminating in normal tetrads of nuclei without micronuclei, in this individual prompts the interpretation that individual 10 is tetraploid as well.

Pollen diameters from the transplant garden can be used to extend the counts of the two individuals to their respective populations, because pollen diameter is correlated with polyploid level (Kowal 1975; Mahoney & Kowal ms. subm.). A nested ANOVA indicates that the difference in mean pollen diameter between the North Carolinian and Virginian populations, 27.9 vs. 31.2 µm, is real ($F_{1,8} = 24.16$, $p = 0.0018$) and that individuals within each population do not differ ($F_{8,7} = 2.19$, $p = 0.16$). Taken together, this implies that the populations, the former containing an individual with $n = 22$ and the latter with n = ca. 44, consist of all diploids and all tetraploids, respectively. ANOVAs testing for differences among individuals within the two populations separately give absolutely no evidence ($F_{5,7} = 0.46$, $p = 0.80$) of differences in pollen diameter (and, implicitly chromosome number) in the "diploid" population but moderate evidence ($F_{3,7} = 5.11$, $p = 0.035$) in the "tetraploid" population. However, the one individual with unusually small pollen diameter (29.0 µm) is, in fact, individual 10, which is approximately tetraploid, so its aberrancy has other causes.

Uttal (1982) notes that among the specimens from Madison Co., NC (presumably the Paint Rock Road population), he saw hybrids with *P. anonyma*. This species does occur ca. 0.5 miles downstream from the var. *appalachiana* population, and 3 of the 11 individuals collected in 1995 showed morphological similarities to *P. anonyma*. Introgression here is likely, but none of the individuals in the transplant garden provided any obvious evidence of it.

Uttal (1982) reports that *P. aurea* and *P. paupercula* var. *appalachiana* (as "*P. plattensis*") "thoroughly introgress" along McCoy Road (rt. 652). Individual 10 grew on the road cut and individual 9 grew nearby, on the bluff's edge; the other individuals were from less disturbed bluff sites. Some individuals, in particular #9, have deeply pinnatifid cauline leaves with wide, distally dilated lobes and broad, undivided terminal lobes like *P. aurea*, which is rampant in an apparent sink-hole in the woodland above the bluff. A garden-grown individual of *P. aurea* from this site is lighter green than is typical for the species and

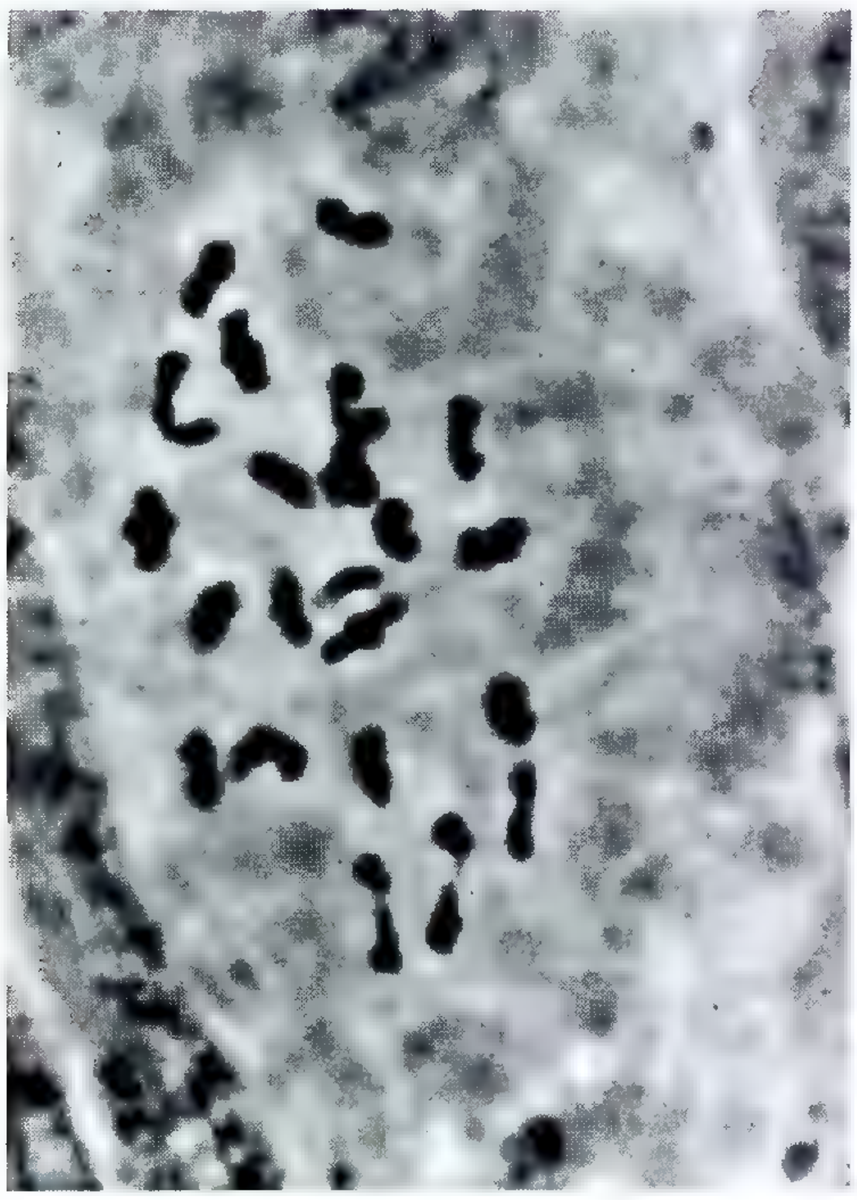


FIG. 2. NC, Paint Rock Road, #9. Metaphase I, $2n = 22$ II.



FIG. 3. NC, Paint Rock Road, #9. Metaphase II, $2n = 22 + 22$.

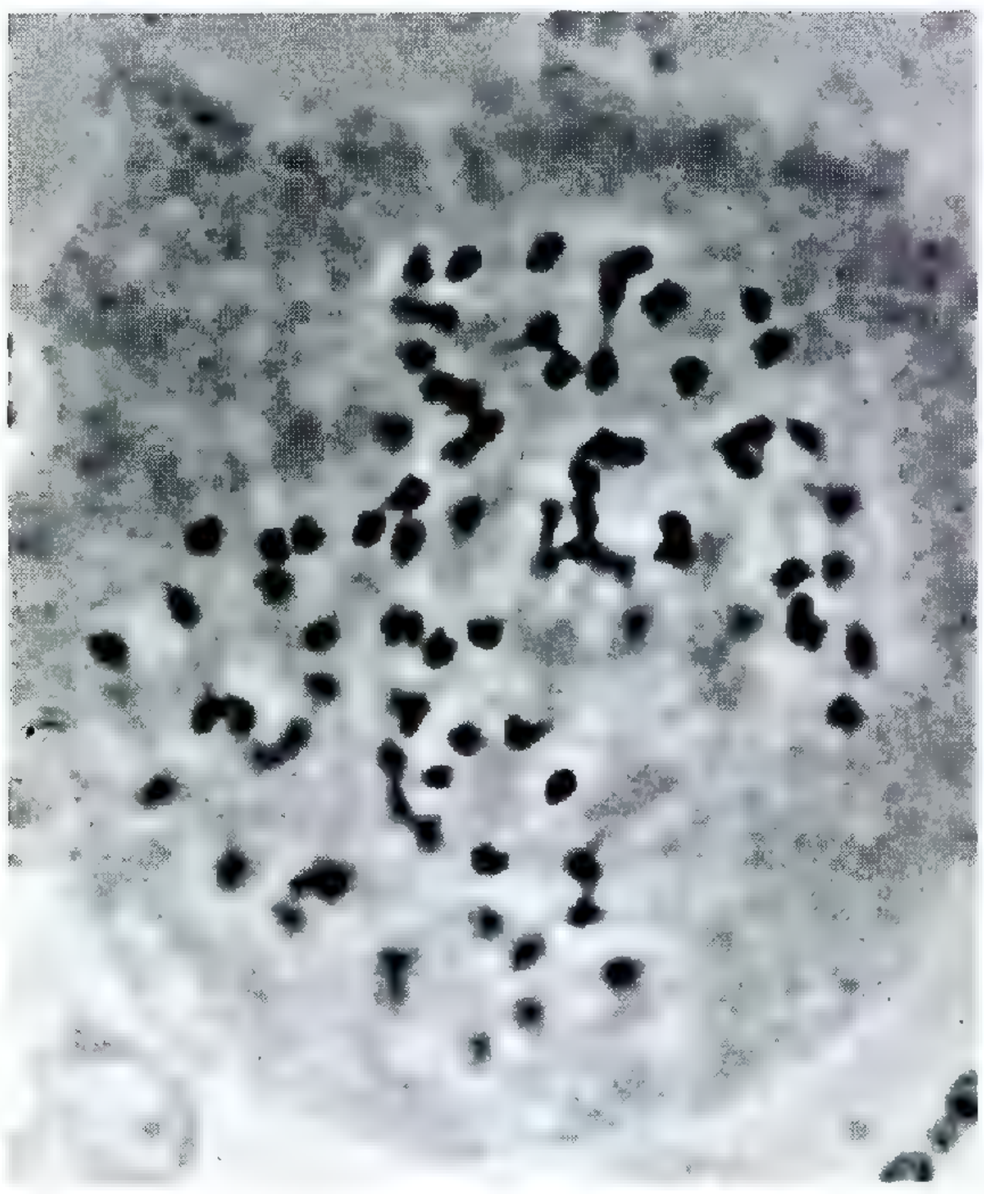


FIG. 4. VA, Lover's Leap, #9. Late anaphase I, $2n = 22 + ca$, 88.

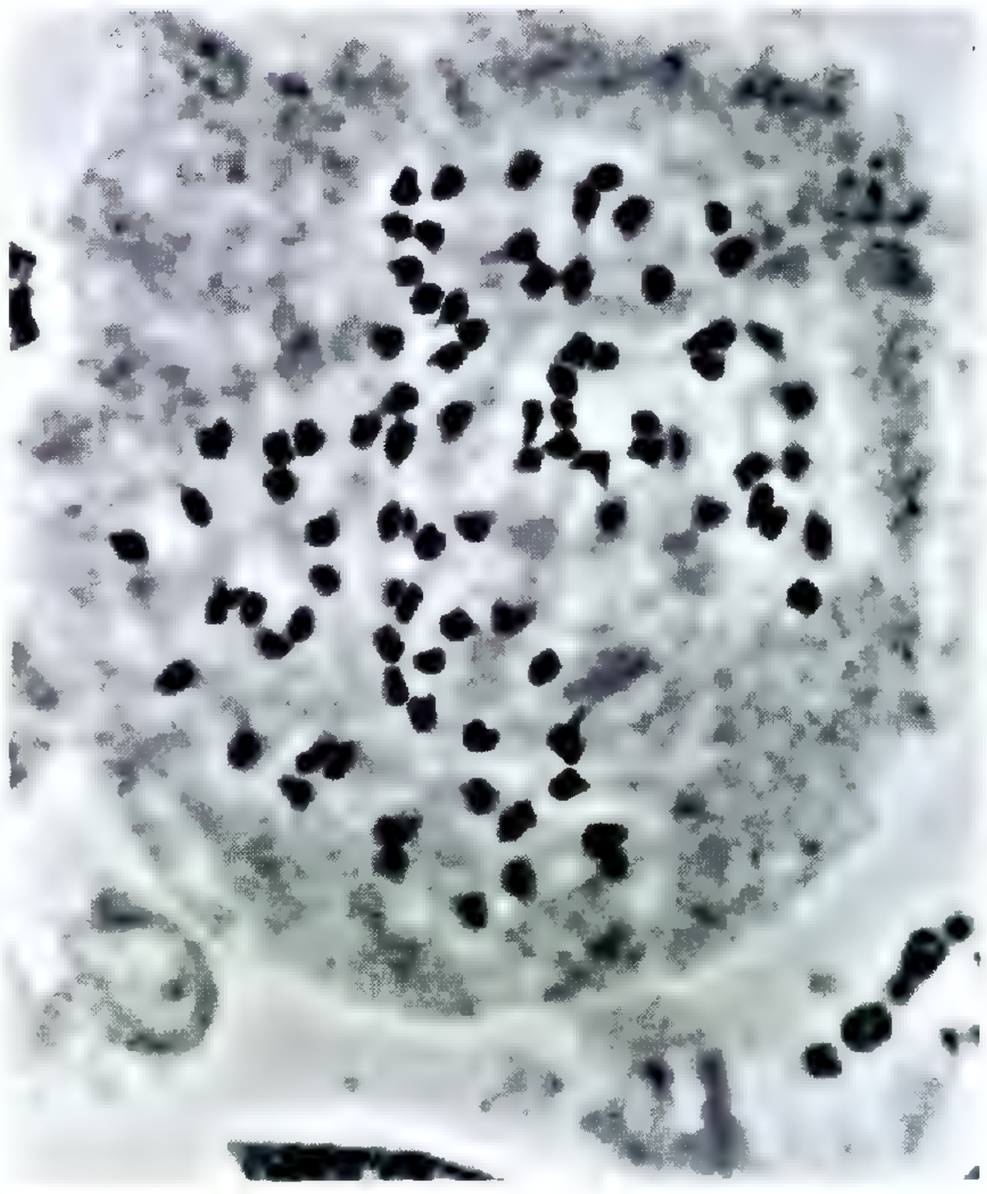


FIG. 5. Figure 3 retouched using Corel Photo-Paint 8.

reproduces abundantly and invasively by adventitious shoots on roots, unlike normal *P. aurea*. Therefore, it is likely that at least a portion of the Lover's Leap population is introgressed with *P. aurea*.

Chromosome counts indicate that *Packera plattensis* does not occur in the central Appalachians. This Great Plains species appears to be entirely tetraploid with $x = 23$ and the North Carolinian population is diploid with $x = 22$. At least some members of the Lover's Leap population in Virginia are tetraploid but probably with $x = 22$. This evidence supports the morphological and RAPDs evidence that these central Appalachian populations are best treated as *P. paupercula* var. *appalachiana* (Mahoney & Kowal ms. subm.).

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NORWEGIAN AND SÁMI ETHNOBOTANY OF *VERATRUM ALBUM* (MELANTHIACEAE)

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ABSTRACT

In Fennoscandia, *Veratrum album* L. (Melanthiaceae) is restricted to the northernmost part of Norway, Finland and Russia. It is locally abundant in coastal areas of northeast Finnmark (Norway), and well known in both Norwegian and Sámi folk tradition as a toxic plant, frequently causing livestock poisoning. Until replaced by tobacco, the roots were used as snuff by the Sámi, who had also found restricted use of the plant for medicinal purposes, e.g. as a remedy for rheumatism.

RESUMEN

En Fennoscandia, *Veratrum album* L. (Melanthiaceae) está restrigida a la parte norte de Noruega, Finlandia y Rusia. Es localmente abundante en areas costeras del noreste de Finnmark (Norway), y bien conocida tanto la tradición noruega como en la finlandesa como planta toxica, que causa frecuentemente envenenamiento del ganado. Hasta que fue reemplazado por el tabaco, las raíces fueron usadas como rape por los finlandeses, quienes también encontraron un uso restringido de la planta con fines medicinales, por ejemplo como remedio para el reumatismo.

NORWEGIAN SAMMENDRAG

I Fennoskandia finnes *Veratrum album* L. (Melanthiaceae) bare i den nordligste delen av Norge, Finland og Russland. Arten er lokalt vanlig i kysttraktene i NØ-Finnmark (Norge), og velkjent både i norsk og samisk tradisjon som en farlig giftplante, som ofte er opphav til forgiftning av husdyr. Den ble tidligere brukt som snus av samene, en rolle tobakk nå helt har overtatt. I samisk tradisjon har arten også spilt en viss rolle som medisinplante, bl.a. som en kur for reumatisme.

INTRODUCTION

Veratrum album L. (Melanthiaceae) is a rare species in Fennoscandia, and confined to the area's northeastern part—the Kola peninsula in Russia (Pojarkova 1966), Finnmark in Norway (Alm 1991a), and a single, somewhat disjunct station in northeast Finland (Hämet-Ahti et al. 1998). The plants found in Fennoscandia have yellow-green flowers, and are sometimes referred to *V. album* var. *virescens* Gaudin, although their relationship to middle European plants, where both white- and yellow-flowered forms occur, has not been investigated.

Within its Norwegian distribution area, *V. album* is common locally, and often predominant on meadows, especially along brooks and rivers. It is also found in tree-less subarctic areas along the outermost coast, and grows vigorously even in *Empetrum* heath and *Salix herbacea*-type snowbeds (Alm 1991a, 1991b, 1991c).

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Veratrum album is easily recognized, due to its large size and characteristic habit. Within the species' distribution area in Finnmark, both Norwegian and Sámi inhabitants have noted and named the species, for which a one-to-one relationship exists between the ethnotaxonomical unit and the scientific species (sensu Berlin 1992).

In a previous paper (Alm 1991b), dealing mainly with the species' distribution and ecology in Norway, I have included some data on the ethnobotany of *Veratrum album*, compiled from various literature sources. The present paper presents an expanded and revised compilation of ethnobotanical data, and adds recent ethnobotanical information from interviews with local inhabitants of both Norwegian and Sámi descent in Finnmark. Transcripts and recordings of the original interviews are stored at the Department of botany, Tromsø museum (TROM).

VERNACULAR NAMES

The vernacular names used for *Veratrum album* in Finnmark are all related to its toxicity. A characteristic feature of the chemical components of *V. album* is their ability to cause sneezing (Frohne & Pfänder 1983). The only Norwegian vernacular name recorded for *V. album*, *nysrot* or *nyserot* ("sneeze root"), reflects this property. The latter form is now also well established as an "official" (e.g. in floras) Norwegian name for the species. As such, it was first used by Gunnerus (1772).

Gunnerus mentioned two Norwegian names for *V. album*, *Hviit Nysegras* (*hvitt nysegras* in modern Norwegian), i.e. "white sneeze-grass," and *Hviit Nyseroot* (= *hvit nyserot*), i.e. "white sneeze-root." Although his flora includes much ethnobotanical information, vernacular names provided by Gunnerus should be treated with some caution. Gunnerus coined Norwegian names for numerous species, including e.g. many fungi that had little or no chance of being recognized by the layman (Eckblad & Høiland 1985). In the case of *Veratrum*, at least the preceding *hvit* ("white") must have been added by Gunnerus, probably by translating the Latin epithet of *V. album*; there is no factual basis for connecting this term with the yellow-flowered specimens found in Norway. This comment also applies to the notion of *Hvid Nyserot* as a Norwegian vernacular name in Wahlenberg (1833).

Gunnerus' original record had no indication of colour, and was a straightforward *Nyseroot* or *Nysroot*, as revealed by his letters to Carl von Linné (Linnaeus) dated 13 February and 1 April 1768 (printed in Amundsen 1976; originals in the Linnaean Society, London). Furthermore, *nyserot* has now been confirmed as a genuine and still extant vernacular name in Finnmark by interviews e.g. at the Nordkinn peninsula.

The most frequent Sámi name for *Veratrum album* is *gastinrássi* (in mod-

ern North Sámi, *gastemrasse* in older spelling), of similar meaning ("sneeze plant"); from *gastin*, to sneeze, and *rássi*, "grass" or "plant"—the latter being a preferable translation. It was first recorded by K. Leem and J.E. Gunnerus in the mid-18th century (Alm 1991b; Gunnerus 1772; Nielsen & Nesheim 1979; Qvigstad 1901), and was also noted by Wahlenberg (1812) during his 1801 visit to Finnmark. It is still widely known in Finnmark (interviews 1996).

A deviant Sámi name, *mirkkorássi* ("poisonous plant") has been recorded in the Deatnu/Tana area. It was first mentioned by Qvigstad (1901), but in ethnobotanical context as a *nomen nudum*, as he did not identify the species. Alm (1991b) suggested that the name might refer to *Veratrum album*; this has now been confirmed by interviews with Sámi inhabitants in the Sieiddá area of Deatnu/Tana.

HUMAN USE

Literature sources reveal past use of *Veratrum album* by the Finnmark Sámi as a kind of snuff, perhaps with intoxicating abilities. Such use was first suggested by Hans Lilienskiold, district governor of Finnmark in the late 17th century, and author of a large, hand-written description of the area:

"If the tobacco-hungry knew the root"s strength, little would be left standing" (cited from the printed version in Solberg 1942–43; translated from Norwegian).

Gunnerus (1772) noted that the Sámi used the pulverized root as a kind of sneezing powder, i.e. as snuff. A slightly more detailed description was given by Jens Rathke, in an account of his 1801–1802 journey in Finnmark:

"The use of the roots of this plant as snuff-tobacco has formerly been very frequent among the Sámi, but is now increasingly substituted by [ordinary] tobacco (...)" (Rathke 1899; translated from Norwegian).

Use of *Veratrum* as snuff was also noted by the Swedish botanist Göran Wahlenberg during his 1801 visit in Finnmark (Qvigstad 1932). A single 20th century record of this practice is found in Lillevik (1970), who noted that a Sámi walking companion at the Nordkinn peninsula was eagerly interested in some *Veratrum* stands they passed, showing visible pleasure. Lillevik (op.cit.) also noted that only full-grown plants were selected for human use.

The effects of using *Veratrum* snuff are not described in any Norwegian sources. The roots have a strong and bitter taste (Hoppe 1975). According to Frohne and Pfänder (1983), 1–2 grams of the dried root may be lethal for humans. However, since the poisonous constituents provoke violent sneezing, it is hardly possible to consume such amounts, except in alcoholic extracts (Hruby et al. 1981). Used as snuff, the *Veratrum* powder was supposedly spit out in a short while, certainly after causing some sort of sensation. There are no records of any kind of intoxication, although *V. album* is known to possess psychoactive abilities (Rätsch 1998). In fact, sneezing may have been just the desired effect; in

Sámi folk medicine, sneezing was considered healthy, probably as a way of "getting rid of" diseases; ordinary tobacco has also been much used to provoke sneezing (Qvigstad 1932).

Apart from this, *V. album* has found little use in folk medicine. According to Qvigstad (1932), Wahlenberg had noted that *Veratrum* was used to treat rheumatism in Finnmark. No further details are known, e.g. on ethnicity of those who used it, but it is likely to be a Sámi tradition. According to Steen (1961), Sámi inhabitants of the Lyngen area of Troms, North Norway, used *V. album* to treat rheumatism. If so, the cure must have been based on plant material imported from Finnmark, as the Lyngen area is situated far outside the present distribution of *V. album*. Steen suggests that the cure was carried out mainly by drinking a decoction of *Veratrum*; surely a dangerous practice. It could also be applied as a compress on the painful area.

Gunnerus (1772) listed a whole range of diseases that could be treated with *Veratrum*, but his account seems to be based on literary sources related to Central Europe, including Gouan (1765). Hiorthøy (1785) mentioned *Veratrum* as a cure for psychic disorders in Gudbrandsdalen, southeast Norway, again probably based on a learned tradition, and certainly on imported plant material—the nearest stations with indigenous *V. album* are situated in Central Europe; the plant used may have been *Helleborus niger* (Reichborn-Kjennerud 1922).

LIVESTOCK POISONING

Veratrum album is strongly poisonous (Bertrand et al. 1990; Frohne & Pfänder 1983; Hoppe 1975; Jaspersen-Schib et al. 1996; Keeler et al. 1978; Quatrehomme et al. 1993). In Finnmark, this is well known to anyone living in areas with large stands (Alm 1991b; Høeg 1974; Lillevik 1970). However, since the plants sprout in early spring, and unfold considerable leafage before almost any other herbs, they are frequently consumed by animals. The resulting poisoning was first commented on by Lilienskiold in the late 17th century:

"When the creatures eat its leaves in abundance towards spring, it affects their hairs, which are felled" (cited from the printed version in Solberg 1942–43; translated from Norwegian).

Lethal poisoning of a small herd of cattle was reported from the Deatnu/Tana area in Finnmark by Ruud (1938). Dissection showed haemorrhages of the heart, stomach and intestines, liver damage, and lungs with a bloody foam. The incident occurred in June, in circumstances that were typical of past poverty. Both in Norwegian and Sámi husbandry, the animals were customarily hunger-fed during the latter part of winter, and would eagerly eat anything available when released in spring—including the large, but poisonous shoots of *Veratrum album*.

Nowadays, the remaining cattle in Finnmark are usually fed on cultivated pastures, and poisoning is unlikely to occur. Sheep, on the other hand, frequently

eat shoots of *Veratrum album*. According to people at the Nordkinn peninsula, lambs would often consume at least some leaves of *Veratrum*. Poisoning is rarely lethal (though death may occur, as suggested by Lillevik 1970), but causes severe sickness, characterized by a "foam" issuing from the mouth. A recent description may be included:

"*Nysrota* ... it is the worst weed we've got. Almost every lamb will eat it, and then they get this foam at the mouth." ... "It becomes all foam. It's really awful, it even gets into the eyes" (interview 1994; translated from Norwegian).

Vomiting is frequent (Høeg 1974). According to people at Værnes (Nordkinn peninsula), the only remedy that would help was giving the affected sheep milk. When symptoms subdued, the lambs seemed to suffer no lasting consequences—and would subsequently avoid *Veratrum*, for which reason grown-up sheep are rarely affected (interview 1994).

CONTROL MEASURES

As a consequence of livestock poisoning, farmers in Finnmark at least formerly tried to decimate or eradicate *V. album*—a difficult task, given that the species has very effective vegetative propagation by its thick rhizomes. The Norwegian botanist J.M. Norman made a characteristic observation at Bonjákas in Deatnu/Tana in the late 19th century:

[*Veratrum album* occurs] "in large quantity, sometimes expanding into sites, where is was not previously noted, and threatening during the [18]80's to become a real pest, in particular in spring, when the livestock is released. One tries to curb its further spread by scything it in early spring" (Norman 1900; translated from Norwegian).

The Swedish botanist Nikolaus Svensson noted a similar practice during an 1892 visit to Deatnu/Tana:

[*Veratrum album*] "is very frequent around the Tana fjord and ascends high up into the mountains, but only in the immediate vicinity of the fjord. In Tana, a veritable war of extermination is fought against it due to its toxicity. However, it seemed to manage well, and often grew as high as a man on the small pastures along the river" (Svensson 1894; translated from Swedish).

Conscious eradication may explain the present absence of *V. album* from several sites in Finnmark where literature records suggest that it did occur in the 18th and 19th century, e.g. at Nordkapp and Porsanger (Gunnerus 1772; Wahlenberg 1812) and Vardø (Solberg 1942–43), well outside the present range (see map in Alm 1991b).

Stands of *V. album* with all stems cut at base level—obviously as a control measure—were observed in Deatnu/Tana as late as in 1975 (Alm 1991b). Such practices are probably rare by now.

At present, *V. album* is frequent on meadows e.g. in Deatnu/Tana, and little effort seems to be directed at controlling it. This is partly a consequence of

altered agricultural practices; numerous farms have been deserted, and those remaining have largely adopted modern practices of intensive grass cultivation; the former extensive use of both in- and outfield areas is hardly practised. Like many other large herbs, *V. album* thrives on abandoned meadows, and is probably more common nowadays than in the past.

VERATRUM IN OTHER AREAS

Veratrum album is widely distributed in Eurasia, from Spain to Beringia (Hultén & Fries 1986), with a close relative (*V. viride* Ait.) in North America. The latter is also strongly poisonous (Prince & Stork 2000). Throughout the area, *Veratrum*'s characteristic ability to cause sneezing has been well known.

Veratrum album is found in the mountains of mainland Greece, and may have been known to the ancient Greeks, though to what extent it was used is disputed. Theophrastus (book IX, X) noted that "The white and the black hellebore appear to have nothing in common except the name" (Hort 1916). According to Baumann (1993), *V. album* was not used by the Greeks, wheras Rätsch (1998) suggested that it was considered a medicinal plant of prime importance. Raven (2000) rejected previous identifications of the white hellebore of the ancient Greeks, and suggested *Drimia maritima* (L.) Stearn, syn. *Urginea maritima* (L.) Baker, as a more likely candidate, whereas the "black hellebore" probably refer to *Helleborus* species.

Just as in Sámi tradition, the Greeks (as recorded by Pliny the elder) considered sneezing as a way to promote health, by forcing the demons of disease to leave the body; its main use was for psychic diseases (e.g. depression), epilepsy, etc. (Rätsch 1998). Similar use is mentioned in early printed European herbals, e.g. Fuchs (1543).

In Italy, an extract of *Veratrum album* roots in alcohol has served as an antirheumatic remedy (Cappelletti et al. 1982). In Iranian folk tradition, a paste of the fresh root of *Veratrum* is used externally to relieve headache and neuralgic pains (Hooper 1937).

In North America, numerous Indian tribes have used *Veratrum* species for medicinal and other purposes (Moerman 1998). Antirheumatic use of *V. viride* is rather widespread, and known e.g. among the Bella Coola, Cherokee, Gitksan, Haisla, Hanaksiala, Iroquois, Kitasoo, Okanagan-Colville, Oweekeno, Quinault, Salish Thompson, and Tsimishian tribes (Gottesfield & Anderson 1988; Gunther 1988; Moerman 1998; Smith 1929; Turner et al. 1980, 1990). The Blackfoot Indians used powdered *Veratrum viride* to provoke sneezing and thus clear the respiration tract (Hart 1979). *V. californicum* Dur. has been used as a remedy for rheumatism, wounds and sores, and as a contraceptive (Kelly 1932; Train et al. 1941).

Veratrum species feature in a variety of other folk beliefs and traditions among the Indians of North America. The Gitksan and Haisla Indians made ceremonial use of *V. viride* to drive off evil spirits, and could wear a piece of the

root to ensure good luck, i.e. as an apotropaic. It was also used in purification rituals (Gottesfield & Anderson 1988). Haisla Indian shamans applied the plant to arrows to shoot at and drive off "disease spirits" (Moerman 1998). Among the Okangan-Colville Indians, *V. viride* featured in witchcraft (Turner et al. 1980). Gunther (1988:24) recorded that the Cowlitz indians used a chewed piece of *Veratrum* to scare off sea-monsters.

In summary, the use of *Veratrum* species as an anti-rheumatic remedy is common to the Old (Norway, Italy, Greece) and New World (American Indians). Their ability to provoke sneezing is well known in both areas, and was considered attractive either as a way to expel evil sprits, get rid of disease, or merely regarded "healthy" as in Sámi tradition.

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Book Review

Donald A. Cox. 2002. **A Naturalist's Guide to Wetland Plants: An Ecology for Eastern North America.** Illustrations by Shirley A. Peron. (ISBN 0-8156-0740-7, pbk.) Syracuse University Press. 621 Skytop Road, Suite 110, Syracuse, NY 13244-5290. (Orders: 315-443-2597, Fax: 315-443-5545, supress@syr.edu) $17.95, 203 pp, 123 line drawings, 6" × 9".

Once viewed as wastelands, wetlands are now better appreciated by the public for the value they bring to human life. By some estimates, wetlands once covered more than 200 million acres in the United States. Yet, nearly half of these valuable ecosystems were destroyed by the 1950's for use in agriculture and land development. Recent legislation seeks to protect wetlands and associated biota, yet these ecosystems continue to be destroyed, albeit at a slower rate, and wetland species become threatened or endangered. This book focuses on palustrine wetlands, i.e. marshes, bogs, and swamps and within the first few pages raises the reader's awareness of the value of wetlands.

Beginning, appropriately, with a definition of wetlands as ecosystems, Cox enumerates in the first chapter the value of wetlands as habitat for biota, flood protection, recreation and groundwater recharge, among others. The introduction also touches on wetland productivity and nutrient cycling, with emphasis on carbon dioxide and global climate change due to the burning of fossil fuels. In latter half of the first chapter, some major wetlands in North America are described—the Atchafalaya Swamp, Cranberry Glades of West Virginia, the Everglades, the Great Dismal Swamp, Okefenokee, the Pocosins and prairie pothole marshes. Information about each wetland details geography, dominant vegetation, and historical and current ranges. The next five chapters emphasize the plants that grow in wetlands. Chapter two, entitled Types of Plants, explores the different forms of plant life in wetlands or for that matter, any ecosystem on the planet. Details on the life history and general characteristics of algae, fungi, slime molds, lichens, bryophytes, ferns and allies, gymnosperms and angiosperms are provided. In the next chapter, Strategies for Survival, the author presents pollination syndromes, seed dispersal mechanisms, and adaptations for water in wetland plants. Chapters on marshes and swamps and bogs and peatlands focus primarily on the vascular plants growing there. Though illustrations are scattered throughout the book, more are presented here to enhance the plant descriptions.

In the chapter, Plants of Special Interest, the amount information on poisonous plants far outweighs the details on hallucinogenic and edible plants. In fact, only one hallucinogenic plant is mentioned, sweetflag or *Acorus calamus*, and I found myself wondering about the merit of listing this plant in its own heading because of its psychoactive properties. Perhaps it would have been better served in the medicinal plants section since Native Americans used it to treat some physical ailments.

Transitions in the physical characteristics of wetlands due to seasonal climate change are discussed in chapter seven, Through the Year. Noxious aquatic weeds are also considered in some detail here. The author provides tips on collecting, preserving and identifying plants, including sound advice on where and what not to collect, obtaining permission from land owners prior to collecting and how to collect good, representative specimens. In the final chapter, suggested activities on wetlands, such as making a study on the life history of a plant or investigating the characteristics of a local wetland, encourage readers to learn more.

This book raises awareness regarding the importance of wetlands. The dynamic attributes of ecosystems and interconnected nature of wetland biota is stressed throughout. Clarity and brevity of Cox's writing style makes this book relevant to nearly all groups of people— naturalists, educators, college students, amateurs interested in birds, amphibians, reptiles or plants. Emphasis on conservation and habitat preservation make this book especially valuable.—*Amy Trauth Nare, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102, U.S.A., amy_trauth@yahoo.com.*

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CARLO BERTERO (1789–1831) IN THE NEW WORLD

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ABSTRACT

Carlo Giuseppe Bertero (1789–1831) is, among the famous Italian botanical collectors that contributed toward the knowledge of New World flora, the one who collected and travelled the most. Bertero gathered a large number of specimens, which were in turn distributed to many of his correspondents, and are now present in many herbaria worldwide. During his travels he also collected seeds, which he sent to numerous botanists, contributing toward the collections of private and public gardens. Several hundreds of his botanical collections turned out to be plants unknown to science, which were in turn described by many of his contemporary European botanists. The botanical work of Carlo Bertero in Italy has already been extensively treated by many specialists. Nevertheless, his botanical expeditions and collections in the New World have never been completely studied, although partial reports have already been published. Such studies need further investigations as new data have been recently obtained through correspondence, field books and herbarium label data in order to reconstruct the itineraries and the chronological sequence of Bertero's first expedition to the Antilles and northern Colombia (1816–1821), and his second expedition to Chile (1827–1830), Juan Fernández Islands (1829) and Tahiti (1830–1831). This preliminary study is part of an ongoing project that will produce a complete biography of Carlo Bertero and a comprehensive account of his botanical work in the New World and the South Pacific, that will be published in the near future (Delprete, Forneris & Pistarino, in progress).

KEY WORDS: Carlo Bertero (1789–1831), Giovanni Battista Balbis (1765–1831), Luigi Colla (1766–1848); biography, bibliography, botanical collections, botanical explorations, itineraries; Greater Antilles, Guadalupe, Puerto Rico, Santo Domingo, Jamaica, South America, Colombia, Chile, Juan Fernandez Islands, Tahiti, Society Islands.

RESUMEN

Carlo Giuseppe Bertero (1789–1831) es, entre los famosos colectores botánicos italianos que contribuyeron al conocimiento de la flora del Nuevo Mundo, el que más viajó y colectó. Bertero acopió un gran número de especímenes, que fueron distribuidos a la mayoría de sus correspondientes y que ahora están conservados en muchos herbarios de todo el mundo. Durante sus viajes recolectó también semillas, que mandó a muchos botánicos, contribuyendo a las colecciones de jardines públicos y privados. Varios centenares de sus especímenes se revelaron como especies desconocidas para la ciencia y fueron descritas por varios botánicos europeos contemporáneos. El trabajo botánico de Carlo

Bertero en Italia fue extensamente tratado por muchos especialistas. Sin embargo, sus expediciones y colecciones en el Nuevo Mundo nunca fueron completamente estudiadas, aunque se publicaron algunos reportes parciales. Estos estudios necesitan de ulterior investigación, puesto que fueron obtenidos nuevos datos recientemente a través de su correspondencia, cuadernos de campo y etiquetas de herbario, en el intento por reconstruir los itinerarios y la secuencia cronológica de su primera expedición a Las Antillas y norte de Colombia (1816–1821) y su segunda expedición a Chile (1827–1830), Islas de Juan Fernández (1829) y Tahití (1830–1831). Este estudio preliminar es parte de un proyecto en curso que producirá una biografía completa de Carlo Bertero y una relación comprensiva de su trabajo botánico en el Nuevo Mundo y en el Pacífico Sur, que será publicado en un futuro próximo (Delprete, Forneris & Pistarino, en curso).

PALABRAS CLAVE: Carlo Bertero (1789–1831), Giovanni Battista Balbis (1765–1831), Luigi Colla (1766–1848); biografía, bibliografía, colecciones botánicas, exploraciones botánicas, itinerarios; Antillas Mayores, Guadalupe, Puerto Rico, Santo Domingo, Jamaica, América del Sur, Colombia, Chile, Islas de Juan Fernández, Tahiti, Islas de la Sociedad.

Among the many Italian naturalists who explored the New World, Carlo Giuseppe Bertero (1789–1831) stands out as one of the early collectors who visited little-known or unexplored areas, and for the impressive amount of material that he collected in these regions. The historical, floristic and ecological importance of Bertero's collections is also that they were made in areas that are nowadays almost entirely destroyed, particularly in the Greater Antilles, Chile, and in the Juan Fernández Islands. He engaged two major trips, covering his travel expenses as a medical doctor: the first in the Antilles and the Caribbean coast of Colombia (1816–1821), and the second in central Chile (1827–1830), Juan Fernández Islands (1829) and Tahiti (1830–1831). The bulk of Bertero's collections was shipped to Giovanni Balbis (1765–1831) and Luigi Colla (1766–1848; cf. Delprete 2000), both resident at Torino, and were in turn distributed to many major European herbaria (and now partially present in many North and South American institutions), and his seeds and living material were sent to several European botanical gardens (Spin 1823; Parlatore 1841; Visiani 1855).

A considerable portion of his collections turned out to be genera and species unknown to science, and were described by many contemporary botanists. Most of Bertero's new taxa from the Caribbean region were primarily described by: A.P. de Candolle (1823–73) and Kunth (1833–50) and those from Chile by Moris (1831, 1832, 1833, 1834, 1835), A. de Jussieu (1832), and Colla (1824, 1834, 1835, 1837) among many others (i.e., Balbis, Decaisne, Delessert, Delile, Guillemin, Hooker & Arnott, Montagne, Nees, Philippi, Sprengel, Trinius, Urban and Vignolo-Lutati). Four generic names (*Berteroa* DC., *Berteroella* O.E. Schultz, *Berteromyces* Ciferri and *Terobera* Steud.) and more than 300 specific epithets were dedicated to Bertero (Mattirolo 1932a, 1932b). The correct orthography of specific epithets honoring Bertero has been discussed in Stuessy and Marticorena (1990) and Kartesz and Gandhi (1993). At last, a reef discovered a few years after Bertero's death, was named after him (Bertero's Reef, also Récif Ebrill, Tuamotu Archipelago, 22°40' South, 133°30' West, Pacific Ocean) by J.A.

Morenhout, the Consul of the United States in the Pacific Islands and his last travel companion in the Society Islands.

Bertero also contributed greatly to the knowledge of the Italian flora through his collections before and in-between his two American expeditions. Many authors have focused their work on Bertero's botanical collections in Piedmont (northwestern Italy), which are preserved at TO, in the *Herbarium Pedemontanum* (TO-HP; Re 1827; Bertoloni 1833–54; Colla 1833–37; Burnat 1883; Ferraris & Ferro 1904; Mattirolo 1929; Castiglioni 1931; Steinberg 1971; Vignolo-Lutati 1926, 1927, 1928, 1929, 1932, 1950, 1960; Forneris & Pistarino 1987–88; Forneris & Pistarino 1991; Forneris et al. 1992).

Several authors have dedicated their attention to Bertero's life and work in the Americas (e.g., Vignolo-Lutati 1955, 1956), but the subject has never been treated extensively. Therefore, it has become necessary to start a major project on Bertero's biography and botanical expeditions in the New World (Delprete et al. 2000; Delprete, Forneris & Pistarino, in progress), with the main goals to catalogue Bertero's itineraries and collections, and to produce a study on his life, dedicated to botany, until his premature death caused by a shipwreck in the high seas of the Pacific Ocean. The goal of the present article is to introduce botanists and historians who are interested in the floras of the Americas (and the Society Islands) to Bertero's major accomplishments, and to his dedication and passion for botanical research that lasted until the last day of his short life.

BIBLIOGRAPHIC SOURCES

Bibliographic information has been compiled from the works of many authors who in various occasions have mentioned Bertero's work and life in the New World (Guillemin 1830; Anonymous 1831, 1833, 1834; Hooker & Arnott 1833; Colla 1832, 1839; Astegiano 1857; Candolle 1862; Fournier 1876; Molinari 1880; Urban 1902; Mattirolo 1930, 1932a, 1932b; Gunckel 1931; Looser 1931; Mussa 1931; Vignolo-Lutati 1931a, 1931b, 1951, 1955, 1956; Pichi Sermolli 1951, 1952, 1988; Lanjouw & Stafleu 1954; Perez-Arbeláez 1970; Piovano 1970; Stafleu 1974; Stafleu & Cowan 1976; Del Vitto 1986; Montacchini et al. 1986; Brondino 1989; Forneris et al. 1989; Molinaro 1989; Pistarino & Clemente 1989; Pistarino et al. 1989; Stafleu & Mennega 1993).

Among the works that focused, at least in part, on Bertero's American expeditions, should be mentioned the *Elogio storico dell'Accademico Dottore Carlo Bertero* published by Colla (1839), Bertero's friend and colleague, and the works of Vignolo-Lutati (1955, 1956) and Pistarino et al. (1989). Colla's *Elogio* is particularly important in this biographic project, because he was one of Bertero's dearest friends, and also because it is based on the many letters, with many biographical notes, that were written to him by Bertero. Vignolo-Lutati (1955) studied Bertero's American collections preserved at TO-HG, from the Balbis and

Colla herbaria (for a total of 2,248 taxa), with scholarly work of analysis and organisation [the taxa are arranged according to the Durand (1888) classification, as the specimens still are at TO-HG]. Pistarino et al. (1989) represents the first step of the Bertero Project, of which this article is the logical continuation. Another important source of information is contained in the letters exchanged among Bertero, Colla and Balbis, which are united into 22 volumes of *Corrispondenza botanica e amicale* [Botanical and personal correspondence] and is preserved at the *Biblioteca Reale di Torino* [Royal Library of Turin]. These letters represent an extremely important documentation in the recontruction of the stages of life and the scientific activities of Bertero. A few letters are also preserved at the *Accademia delle Scienze di Torino* [Academy of Sciences of Turin] and at the *Biblioteca Civica di Torino* [Civic Library of Turin]. Nevertheless, Turin is not the only city were Bertero's letters can be found, mostly because he kept close epistolary relationships with many botanists of his time (Anonymous 1831).

Finally, the most important document examined in this study was Bertero's field book of his first trip to the Antilles and northern Colombia (Fig. 2). This precious document, currently preserved at the Library of the Department of Plant Biology of the University of Turin, is a result of 14 field books that were later bound together, to form a book of 1,095 pages, where he described 1,746 collections. The manuscript is in Latin, in Bertero's minute handwriting, and with exhaustive descriptions (sometimes more than one page long), habitats, localities, common names, local medicinal uses, and sometimes augmented by accurate discussions on systematics, taxonomy and nomenclature. In addition, many pages of the manuscript are enriched by Bertero's pencil drawings of morphological details that are often fundamental for the determination of the species collected. This manuscript was donated by Balbis to Augustin Pyramus de Candolle [who used (and sometimes copied) Bertero's descriptions of the Caribbean taxa and published them in the *Prodromus*, 1823–73], and was later returned by Alphonse de Candolle (Augustin's son) to Turin in 1857 (Vignolo-Lutati 1931a; Mattirolo 1932a). Unfortunately, Bertero's field books of his trips in Chile, Juan Fernández Islands and Tahiti have been lost.

BERTERO'S LIFE, TRAVELS, AND BOTANICAL COLLECTIONS

Bertero's Early Years In Europe

Carlo Giuseppe Bertero (Fig. 1) was born on 14 October 1789, in Santa Vittoria d'Alba, a small town in the hilly region of Langhe, about 60 km South of Turin, Piedmont region, northwestern Italy. He studied medicine and natural history at the University of Turin, and later studied botany under the famous botanist Giovanni Battista Balbis, and finally received his Laurea in Medicine in 1811. His doctoral dissertation clearly shows the first signs of his botanical inclina-



FIG. 1. Portrait of Carlo Giuseppe Bertero, with a reproduction of his signature at the bottom of the page.

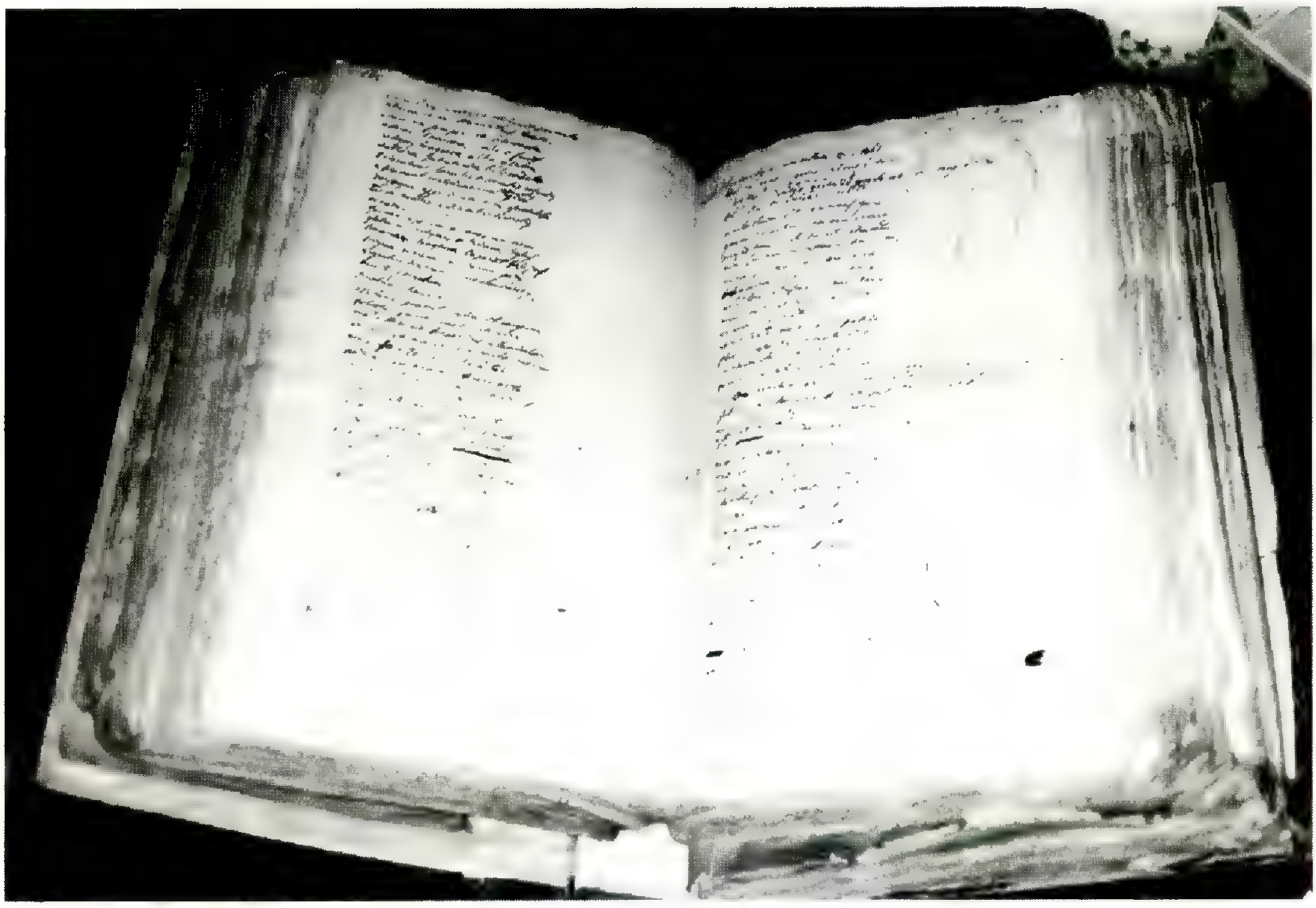


Fig. 2. Photograph of Bertero's field book, compiled by biding his notebooks (14 fascicles with collections numbers, localities, plant descriptions, drawings, etc.) written during his Caribbean expedition (1816–1821).

tion (Bertero, 1811). While studying for his medical degree, he was a frequent visitor to the *Orto Botanico*, and his botanical interests are shown in a letter [hereafter, between brackets are indicated the locality and date of the letters sent by Bertero] (Alba [Piedmont], 21 August 1809) where he asked his botanical master Balbis to find him a copy of the *Flora Pedemontana* of Allioni (1785). In these early years of formation, Bertero strengthened his own botanical knowledge and built the foundation of a strong friendship with Balbis, as is demonstrated in their frequent letters.

In the following years, Bertero proved to be quite successful in the medical sciences, but he refused to continue his medical studies at the *Collegio di Medicina* [College of Medicine], and started eagerly botanizing in the hills and valleys of Piedmont instead. The epistolary relationship between Bertero and Balbis continued strongly through this period, even when the latter moved to Pavia (Torino, 24 May 1815). In these letters, Bertero communicated his frequent botanical collections (Alba, 1 and 7 January 1816, and 6 March 1816) and put his own herbarium at the complete disposition of Balbis (Alba, 7 June 1816) and offered (Alba, 18 March 1816) to help him in the recompilation of the indexes of Willdenow's *Enumeratio plantarum* (1806–1816) and *Species plantarum* (1797–

1825), which were recompiled by Balbis because a great number of taxa were missing in both works.

Before moving to France, Bertero was living in his family home in the small town of Santa Vittoria d'Alba. The frustration caused by the increasing isolation and his desire to be part of the academic world stimulated him to search for objectives outside of Italy. He condensed these feelings of dissatisfaction in a sentence included in a letter that he sent to Balbis: "... Ce qui me console encore c'est que tou[s] mes parents sont persuadés qu'Alba n'est [pas] faite pour moi, n'ayant aucune ressource dans ce pays" [what consoles me is that all my relatives are persuaded that Alba is not made for me, there are no resources in this town (Alba, 7 June 1816)]. In July 1816, with the help of Balbis, who had connections with many European scientific personalities, Bertero moved to Paris. In this city, he had the occasion to meet many famous contemporary botanists as, for example, René Louiche Desfontaines (Paris, 20 July 1816), Jean Louis Loiseleur-Deslongchamps, and Christiaan Hendrik Persoon (Le Havre, 5 August 1816). The Parisian cultural and scientific environment, the study of herbaria containing tropical collections and the frequent visits to the *Jardin des Plantes* contributed to Bertero's rapidly increasing knowledge. It was in this exciting cultural atmosphere, and with the help of Christiaan Persoon (1761–1836), that Bertero decided to the study the flora of the Antilles.

Bertero's Expedition to the Antilles and Colombia (1816–1821)

General Foujaz de Saint Fond, captain of the ship *Guadalupe*, offered an invitation, extended through Persoon, to Bertero to travel on his boat as ship doctor; an offer that he gladly accepted. On August 1816, Bertero departed, on the *Guadalupe*, from the port of Le Havre, with destination to the West Indies. During the trip, the entire crew was infected with yellow fever, and Bertero succeeded in saving most of them, so that at the arrival in Martinique he was welcomed with extraordinary honors.

In Martinique, Bertero was much appreciated as a medical doctor and as naturalist, to the point that he was offered the direction of the local museum of natural history and of the botanical garden. This position Bertero did not accept because he wanted to be free for his botanical explorations. The earliest letter examined documenting his stay in Guadeloupe was dated 31 December 1816, where he affirmed to have collected more than 350 species and to have prepared 100 packages of seeds to be sent to Europe (Pistarino & Forneris 1992).

During this expedition that lasted nearly five years, Bertero visited Guadeloupe in 1816–1818, Saint Thomas in 1818, Puerto Rico in 1818–1819, Santo Domingo (Río Yaqui, etc.), Haiti (Jacmel, Les Cayes, Port-au-Prince, etc.) in 1819–1820, and Colombia (Santa Marta, Barranquilla, Mompós, and the lower Río Magdalena) in 1820–1821. Because of ongoing revolution in Colombia, he returned to Europe, with a short stay in Jamaica, in 1821.

During his stay in the Caribbean region, the correspondence of Bertero with Balbis and Colla is occasional; this may be related to the difficulties of delivering the mail from such remote places to Europe. The letters that we have studied were in chronological order as follows: France: Paris (20 July 1816), Le Havre (5 August 1816); Guadeloupe: Pointe-à-Pitre (31 December 1816), Grande Terre (30 January 1817), Petit Canal (30 May 1817, 15 August 1817, 1 September 1817, 13 May 1818), Pointe-à-Pitre (10 July 1818); Saint Thomas (30 July 1818); Puerto Rico: Patillas (15 January 1819); Hispaniola: Santo Domingo (4 November 1819); Jamaica: Kingston (2 June 1821); France: Paris (3 October 1821).

In several letters (Petit Canal, 1 September 1817; Pointe-à-Pitre, 10 July 1818; Santo Domingo, 4 November 1819), Bertero mentioned several trips that he planned but never realised. Colla (1839), based on the letter of 15 August 1817 from Petit Canal, referred to an itinerary that Bertero planned (and Colla assumed the he realised) from Guadeloupe to Martinique, Trinidad, Tobago and to the mouth of the Orinoco River (Venezuela), to which some other authors have referred in the reconstruction of the itinerary of Bertero's first trip (Astegiano 1857; Molinari 1880). Most likely this trip never took place, and no collections, field books, nor correspondence from any of these areas has ever been found. Urban (1902), studying Bertero's herbarium specimens, was able to make some corrections to the inexact information supplied by Colla about Bertero's trip to the Antilles and northern South America. Urban's corrections and additions were later followed by Mattirolo (1932a, 1932b) and Spada Sermonti (1967). Both specimen labels and correspondence enable us to construct a fairly accurate itinerary of Bertero's first trip (Fig. 3). Also, Table 1 summarises the localities and the periods in which Bertero made botanical collections in the Antilles and in Colombia. This table has been constructed based on data obtained from the above-cited letters, Bertero's field book, and the references published by Vignolo-Lutati (1955), who in turn extracted this information from TO-HG and Bertero's field book.

The botanical research conducted by Bertero in the Antilles took place with many difficulties. The various problems that he referred to in several letters were mostly the amount of time that he had to dedicate to his medical practice, necessary to cover his travel and living expenses, and by the few references available to him for the identification of his own collections (Pointe-à-Pitre, 31 December 1816; Petit Canal, 30 May 1817, and 1 September 1817). In those days Curt Sprengel's (1827) and A.P. de Candolle's (1823–1873) treatments were not yet available; in fact, these texts were published later and were based on many of Bertero's neotropical collections.

He stayed in the West Indies (Jamaica) until the end of July 1821, extremely saddened to have to abandon those beautiful lands but, at the same time, anxious to meet again his relatives after his trip of nearly five years. But what made Bertero even more anxious about his return to Piedmont was the possibility of

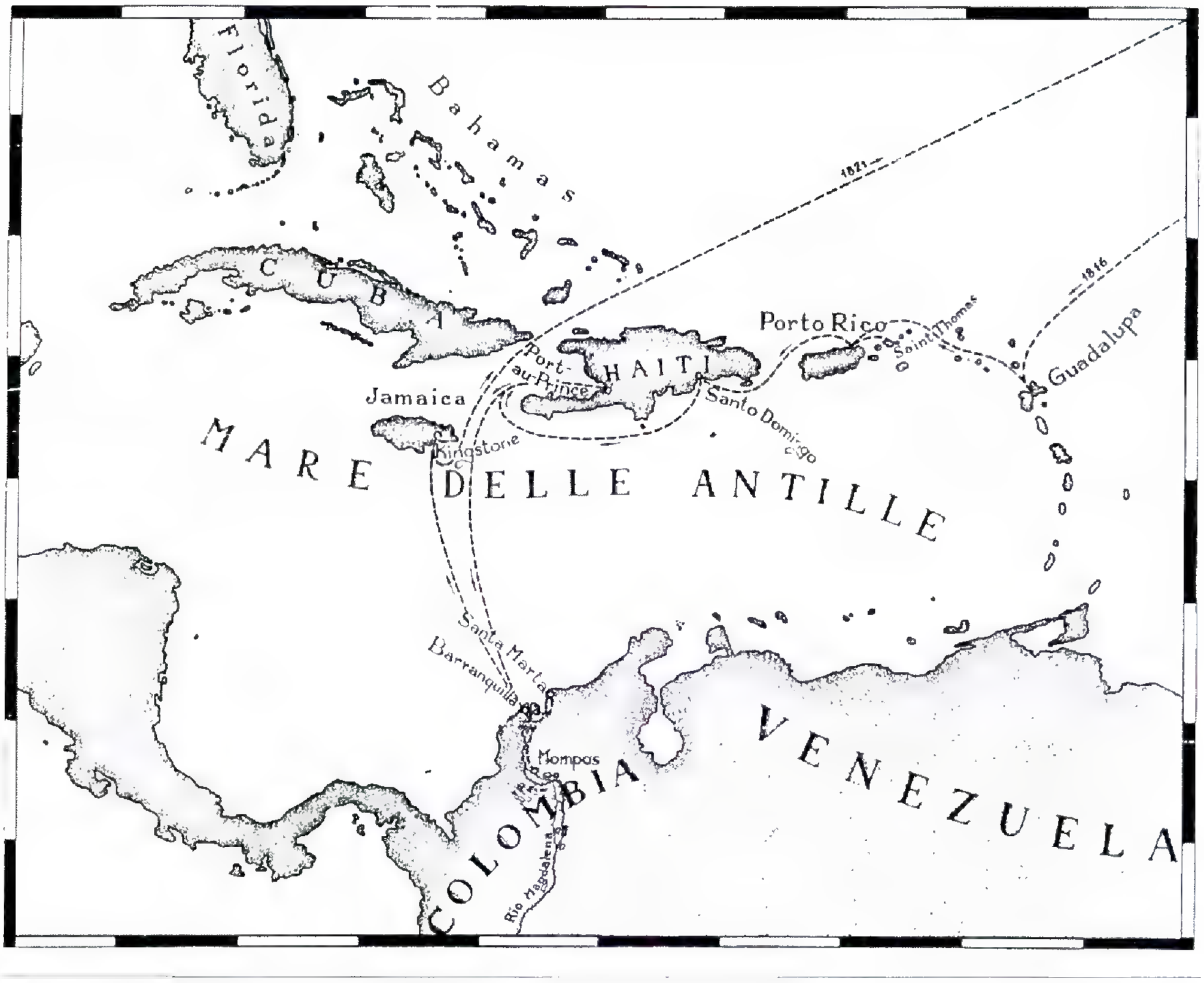


FIG. 3. Map of Bertero's itinerary in the Antilles and Colombia (1816–1821). Reproduced with permission from Molinaro (1989).

meeting Balbis, at Turin, in order to study and determine his new collections, discuss his botanical observations, and update himself on the new publications which had come out during his absence (Kingston, 2 June 1821).

Bertero's collections from the West Indies and Colombia were received by Balbis, who, after a rapid determination by Curt Sprengel (at Halle, Germany), distributed them to various botanists that specialised on Caribbean flora and to several European herbaria. The most substantial set of Bertero's Caribbean collections is preserved at TO-HG, at the University of Turin, which arrived here from Balbis' and Colla's personal herbaria, which was carefully studied by Vignolo-Lutati (1955) and is of cardinal importance in systematic, taxonomic, floristic and monographic studies of the genera occurring in the Greater Antilles (e.g., Anderson 1986; Delprete 1995; Delprete et al. 2000). Duplicate sets of Bertero's Caribbean collections were sent to A.P. de Candolle (G-DC), K. Kunth (B, destroyed), K. Krug (B, destroyed), K. Sprengel (transferred to Urban, B, destroyed), and A. Bertoloni (BOLO; Forneris et al. 1992), to the institutional herbaria of Berlin (B, destroyed), Paris (P), Munich (M), Würzburg (WB), Florence (FI), and additional Bertero's Caribbean specimens are also found at B, FI,

TABLE 1. Summary of Bertero's field book of his trip to the Antilles and northern Colombia (1816–1821), organized by localities, fascicle numbers (notebooks successively numbered by Bertero; fascicle numbers followed by * were pencilled by Vignolo-Lutati), dates, collection numbers, and page numbers of the manuscript.

Fascicles numbers	Collecting dates	Collection numbers	Book pages
In plantas Guadalupenses animadversiones [Guadalupe]			
primus	1816–17	1–212	1–92
secundus	1817	213–412	93–184
tertius	1817	413–587	185–264
quartus	1817–18	588–786	265–360
quintus	1818	787–1079	361–448
sextus	1818	1080–1171	449–529
Stirpium portoricensium historia [Puerto Rico]			
septimus	1818	1172–1232	530–597
octavus	1818	1233–1348	598–685
Plantae domingenses [Santo Domingo, Dominican Republic]			
Nonus* & decimus*	1819–20	1349 1561	686–905
Stirpium ad flumen Magdalena in Amer. merid. lectarum descriptiones [Río Magdalena, Colombia]			
undecimus	1820	1562–1591	906–937
Stirpes in prov. S. Marthae Continent Amer. Australi lectae [Santa Marta Province, Colombia]			
duodecimus	1820–21	1592–1630	938–993
decimustertius	1821	1631–1723	994–1069
[Plants collected in Jamaica, without title in front page]			
decimus quartus*	1821	1724–1747	1070–1082

* The numbers of these fascicles were pencilled by Vignolo-Lutati.

HAL, L, M, MEDEL, MO, MPU, NY, P, P-JU, S, WB and probably some other institutions.

At last, Bertero also collected many samples of seeds in the Greater Antilles and sent them to Balbis, who had active exchange with several European botanical gardens (e.g., Delprete 1995). In many letters preserved at the Biblioteca Reale di Torino it is possible to ascertain the frequent requests from various botanical gardens of the precious seeds collected by Bertero in the West Indies.

Bertero's Return to Europe (1821–1827)

In 1821 Bertero arrived in Paris, and from there he returned to Italy, where he resumed his floristic explorations in Piedmont. In 1825 he was assigned to assist Giuseppe Giacinto Moris (1796–1869) in botanical collections in Sardinia (Moris 1837; Colla 1839; Mussa 1911; Mattirolo 1929; Pistarino et al. 1989), but this collaboration was interrupted. He returned to Santa Vittoria d'Alba and

for some time he continued botanical collections in Piedmont, as documented by his collection in the Gesso Valley of 1826.

Returning to Santa Vittoria d'Alba, Bertero's feelings of frustration, caused by the isolation from cultural centers and the monotony of small town life, were eventually expressed in a letter to Balbis (Alba, 3 March 1826): "... Il faudrait être au courant de la science, avoir des livres en quantité et des correspondants; je suis loin de tout cela, et je me trouve, malgré moi, forcé de rester dans cette inaction" [I need to be up to date with science, and to have books and correspondents; I am far from all that, and I found myself, against my will, forced into this inaction (Alba, 3 March 1826)]. The emptiness left by the death of his much beloved mother, the only bond that could have kept him in Piedmont (Torino, 18 April 1827), made Bertero's desire for new travels irrepressible. In 1827 he returned to Paris, and followed the suggestions made by A.P. de Candolle and B. Delessert (Paris, 25 July 1827) to choose Chile as his next goal, a land that was botanically poorly known at that time. In preparation for this expedition, he consulted the Joseph Dombey herbarium (P), constituted by material collected in southwestern South America with Hippolito Ruiz and José Pavón (Steele 1964).

In several letters from Paris (e.g., 18 August 1827), Bertero communicated to Balbis to be literally harassed by scientists, who masked their interests behind apparent manifestations of friendship in order to gain the favor of receiving a set of his future South American collections. Candolle himself offered him money in exchange for a set of his future Chilean collections, an offer that Bertero refused with disdain. Nevertheless, in his correspondence, Bertero declared his interest in sharing his collections not only with his colleagues Balbis and Colla, but also with A.P. de Candolle and several other botanists. At the same time, Bertero was conscious of the ruthless attitude of some botanists to appropriate materials and results from their colleagues. As a consequence, he considered suitable the offer of Candolle to include the descriptions of his newly found Caribbean taxa in the *Prodromus*, before they would be published by others. Candolle published several hundreds new species based on Bertero's detailed decriptions (sometimes copying them literally) of the Caribbean plants he observed and collected. The field book was returned to the Turin Herbarium 16 years after Bertero's death, by Alphonse de Candolle (A.P. de Candolle's son), with the following inscription on the front page (translated from French): "Bertero, botanical manuscripts, previously donated by Balbis to Aug. Pyramus de Candolle, with the agreement of Bertero, transmitted in 1857 to the Botanical Museum of Turin by Alphonse de Candolle, as a token of recognition for a present that he gave me of dry plants from Brazil. Geneva, 27 October 1857, Alph. de Candolle" (Fig. 4).

In addition, Bertero planned to publish the new taxa that would result from his future South American collections, before they would be supplanted by con-

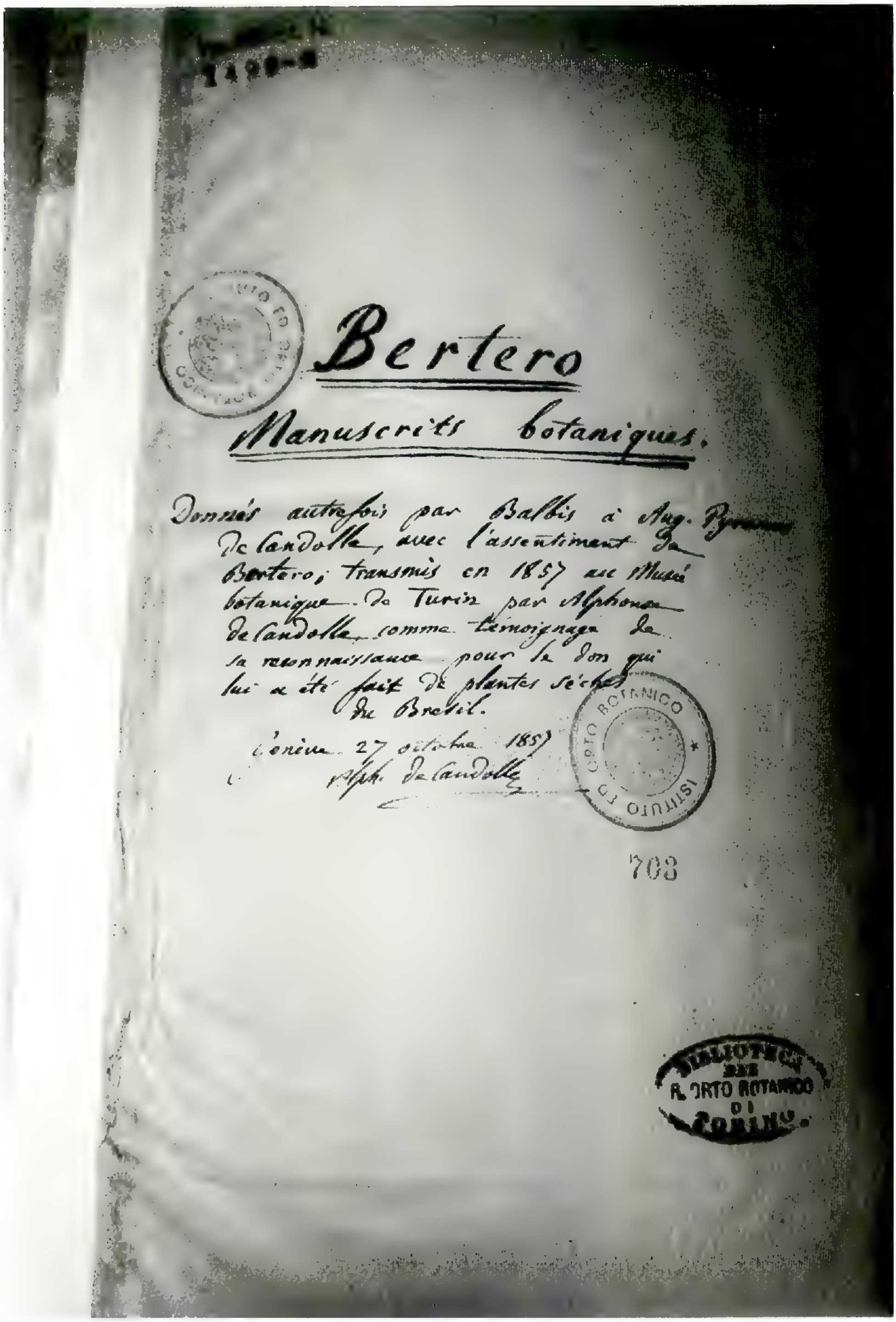


Fig. 4. Photograph of the first page of Bertero's field book, with the writing by Alphonse de Candolle: "Bertero, Manuscrits botaniques, Donnés autrefois par Balbis à Aug. Pyramus de Candolle, avec l'assentiment de Bertero, transmis en 1857 au Musée botanique de Turin par Alphonse de Candolle comme temoignage de sa reconaissance pour le don qui lui a été fait de plantes séches du Bresil. Genève 27 Octobre 1857, Alph. de Candolle."

temporary European botanists. These feelings were expressed in several letters, just before his departure for Chile: "... puisque je me suis de nouveau exposé à des dangers pour faire des découvertes je veux que rien ne parait ce qu'en mon nom..." [... because I have again exposed myself to dangers in order to make discoveries, I want them to appear under my name...] (Paris, 10 August 1827), and "... mon intention était de ramasser des matériaux les quels étant réputés de quelqu'interêt je voulais les publier moi même et payer par ce moyen un juste tribut à mon amour propre..." [... my intention was to accumulate the materials that I regarded of some interest, and wanted to publish them myself and through these means pay a tribute to my self-respect...] (Paris, 18 August 1827).

Bertero's expedition to Chile, Juan Fernández Islands, and Tahiti (1827–1831)

For the second time, Bertero travelled from Paris to Le Havre, and from there, in October 1827, he embarked on a ship with destination Chile, again as a ship doctor. That would be the last time that he saw the European continent. After 112 days of sea voyage, Bertero arrived at Valparaíso, and shortly after he received permission for medical practice in the country, which allowed him to pay his travel and living expenses.

Bertero's explorations in South America turned out to be even more difficult than those he undertook in the Antilles. In fact, in his correspondence he mentioned the many obstacles that he had to overcome: endless rains, impenetrable forests, unusable roads, earthquakes, and frequent dangers of all sorts. In addition, he had to dedicate a considerable part of his time to his medical practice, which he alternated with his botanical work, and had to postpone the shipments of his specimens to Europe several times because of the obstacles encountered in several Chilean ports. To make things more complicated, Bertero travelled in Chile while the country was in revolution (Rancagua, 30 June 1828). The Chilean government contacted Bertero in order to teach a course in Botany and Agriculture, and even planned the creation of an acclimation garden, but these projects were never realized (Valparaíso, 24 June 1829).

Bertero's correspondence with Balbis and Colla includes a wealth of information related to the flora of the regions explored, and documents his travels from Europe to South America, and his life in Chile: France: Paris (25 July 1827, 8 August 1827, 10 August 1827, 18 August 1827, 26 August 1827, 14 September 1827), Le Havre (16 September 1827, 10 October 1827); Chile: Santiago de Chile (11 March 1828, 11 March 1828), Rancagua (17 May 1828, 30 June 1828), Valparaíso (21 June 1829, 24 June 1829, 6 July 1829, 28 November 1829, 28 November 1829, 6 February 1830, 6 February 1830, 6 July 1830, 26 July 1830, 7 August 1830, 10 September 1830).

Contrary to the first expedition, the information that can be extracted from herbarium labels from the second expedition cannot be easily integrated with

the data obtained from his correspondence. In fact, the collection dates of herbarium specimens are limited to the year, reducing the possibility to reconstruct the exact chronological sequence of Bertero's movements (Fig. 5). The only sure data obtained from the material preserved at TO-HG are those correlated with his collections in Valparaíso (June 1829, June–August 1830), Quillota (July 1829), and Juan Fernández Islands (July-November 1829) (Table 2). No herbarium material was found at TO-HG from the trips that he mentioned in various letters (Santiago, 11 March 1828; Valparaíso, 24 June 1829, 6 July 1829, 26 July 1830), in the surroundings of Concepción, Petorca and Coquimbo. Nevertheless, in a letter (preserved at the Academy of Sciences of Turin) he mentioned the sending of a sample of native silver, extracted from the mines of Coquimbo, to the Academy of Sciences of Turin.

In Chile, he collected mostly in the central region. First he botanized in the surroundings of Valparaíso, and then in Viña del Mar and Quillota, on his way to Santiago; from there he travelled south to Rancagua. It is still doubtful if he travelled to Concepción, Petorca and Coquimbo, which he mentions in one letter to Colla (see below). Some references related to Bertero's work in the region were published by the Royal Society of London (1867), Pritzel (1871), Saccardo (1895-1901), Vignolo-Lutati (1956), Stafleu & Cowan (1976), and Del Vitto (1986).

Bertero published an account on the Chilean plants known to him in several articles in *El Mercurio Chileno* (Bertero 1828–1829), where taxa were listed alphabetically, with notes on common names, their uses and peculiarities. This work remained incomplete, arriving only to the letter Q, and was ended with "(Se concluirá)" [to be concluded], because the publication of the journal was stopped, due to political turmoil. Bertero's articles were translated in Italian (Colla 1829a, 1829b, 1830), English (Bertero 1831, 1833) and German (Bertero 1832) immediately after their publication in Chile, and reprinted with notes by Looser (1931), proving the importance of his work. Unfortunately, Bertero's new taxa were not supplied with a description and should be treated as *nomina nuda* (invalid names according to the code of botanical nomenclature - Greuter et al. 2000). The logical continuation to Bertero's work published in the *Mercurio Chileno* is to be found in Colla's *Plantae rariores in regionibus chilensibus* (Colla 1834, 1835, 1837) and Moris' *Plantae chilenses novae minusque cognitae* (1834, 1835). Also, a few of Bertero's new taxa were described by Moris (1831, 1832, 1833) from plants grown in the Royal Botanical Gardens of Turin (from seeds sent by Bertero from Chile). In addition, Bertero's new taxa from his Chilean collections were published in the works of many botanists from all over Europe, sometimes validating his *nomina nuda*, or disregarding his proposed binomials.

In his botanical observations in Chile, Bertero was also the first to realize that *Cyttaria* (Ascomycetes, described by Berkeley, 1841) was a fungus, and not the strange "fruits" of *Nothofagus* (Minter et al. 1987).

Because of the ongoing war in Chile, he had to discontinue his medical

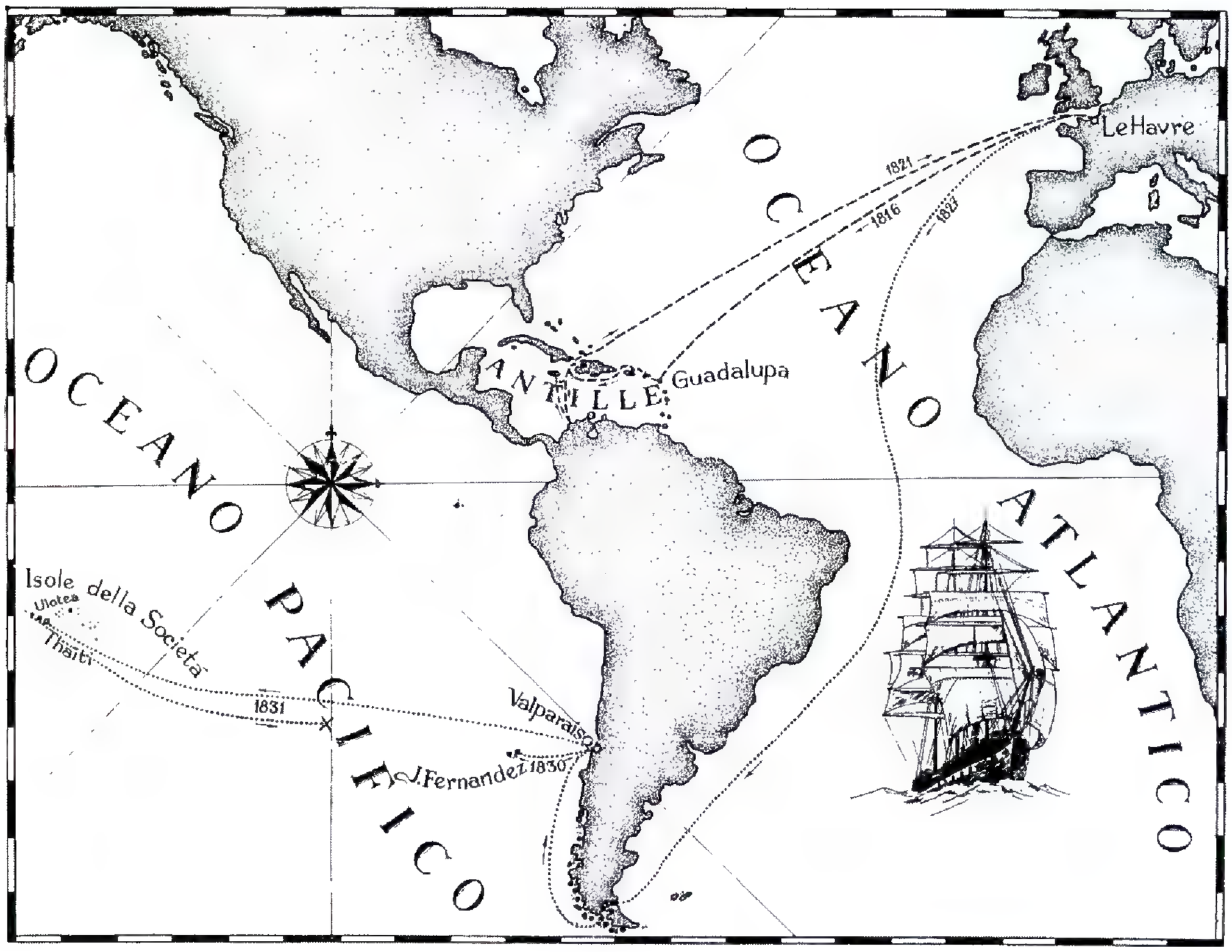


Fig. 5. Map of both Bertero's two itineraries in the Antilles and Colombia (1816–1821), and in Chile, Juan Fernández Islands, and Tahiti (1827–1831). Reproduced with permission from Molinaro (1989).

Table 2. Bertero's main localities and dates of his trips to Chile, Juan Fernández Islands, and Tahiti (1827–1831). Localities and periods were extracted from the letters exchanged among Bertero, Colla and Balbis, and from labels of herbarium specimens preserved at the Turin Herbarium (TO-HG).

Localities	Collection periods
Valparaíso	February 1828
Santiago	March 1828
Rancagua	March 1828–February 1829
Santiago	March–May 1829
Valparaíso	June 1829
Juan Fernandez Islands	July–November 1829
Valparaíso	December 1829–February 1830
Quillota	March–May 1830
Tahiti	November 1830–April 1831

practice. Therefore, from March to May 1830, he visited the Isla Más a Tierra, of the Juan Fernández Islands, accompanied by A. Caldeleugh, and returned to Chile with plant specimens accounting for about 300 species. Guillemin (1830)

published an extract of one letter written by Bertero, dated Valparaíso 7 July 1830, on the natural history of the Juan Fernández Islands. This account, for which Bertero should be rightly considered the author, is the first scientific observations of this archipelago. Among the plants collected by Bertero in Juan Fernandez Islands, should be mentioned the genus *Rea*, a name that he proposed in a letter to Colla (February-March 1830), and that was later published by M.J. Decaisne (1833). Unfortunately, this genus was described one year earlier by David Don (1832) as *Dendroseris*, and *Rea* should be treated as synonymous to it. Regarding the cryptogams collected by Bertero in Juan Fernandez Islands, the vast majority of the new taxa were described by Camille Montagne (1835a, 1835b).

On 28 September 1830, Bertero sailed from Chile, with the General Consul of North America J.A. Morenhout, to the Society Islands and arrived at Tahiti on 4 November 1830. Detailed information on Bertero's trip to Tahiti was supplied in a letter written by Morenhout (25 March 1832; Vignolo-Lutati 1956). According to Morenhout, as Bertero arrived in Tahiti, he immediately started actively botanizing and made substantial collections. A few months later, as he received news about the ongoing revolution in France, Bertero sailed on a small boat (of Morenhout's property) directed to Valparaíso on 2 April 1831, leaving his Tahitian collections to Morenhout, and arriving on the same day at the small island of Raiatea (Society Islands), where he made his last botanical collections. From Raiatea, Bertero wrote two letters (2 April 1831 to Colla, and 9 April 1831 to Morenhout); these were his last communications, at the young age of 42. In his last letter to Colla, probably feeling a premonition of his imminent death, Bertero wrote: "Adieu, bonne Santé, un Pater et un Ave pour mon âme dans le cas qu'elle soit submergée!" [Good bye, and good health, recite a Pater Noster and an Ave Maria for my soul in case that it will be sunk!].

Almost one year later, after loosing any hope of Bertero's survival, Morenhout wrote a long letter (25 March 1832) to the Academy of Sciences of Turin, where he informed them of Bertero's disappearance, and of his grand future plans to explore Peru, return to Colombia, and start his explorations in North America. Morenhout concluded his letter with the following sad notes (free translation from French): "Destiny has not permitted that he [Bertero] realized his grand projects, as he never stopped loving his interesting research! He deserves the sorrow of all his friends in science, and most of all from You, Sirs [the members of the Academy of Sciences of Turin], and from his homeland that he always fondly remembered. Honoured by his friendship, I have known the most intense sentiments of his soul, and I know that he had no other passion than Botany nor other ambition than being proud of You and his Homeland!"

While still in Chile, Bertero sent his collections to Baron Delessert at Paris, who took the responsibility of distributing duplicate sets to Balbis (now at TO-HG), Colla (now at TO-HG) and A.P. de Candolle (G-DC), keeping one for him-

self (G-DEL), and conserving the rest for the return of Bertero, as he explained in several letters from Paris (10, 18, and 26 August 1827) and from Valparaíso (24 June and 6 July 1829). Fearing that some of the boxes might become lost, Bertero also planned duplicate sets to be sent directly to Balbis (Paris, 26 August 1827). Such a plan was not followed, however, because Bertero did not receive any communications from Balbis for more than a year and a half. The last letters sent from Balbis were dated 3 August 1828 and 31 January 1829, which were delivered contemporarily to Bertero on June 1829 (Valparaíso, 24 June 1829).

Bertero's entire collection from Chile—approximately 15,000 specimens—was sold by Delessert's heirs at an auction, several years after Bertero was declared lost at sea. The collection was bought for 1,200 Francs by the travel company Unio Itineraria ("Reise Verein"), based at Esslingen (Germany) and owned by E. Steudel and C.F. Hochstetter. Unio Itineraria dismantled Bertero's Chilean collection, and sold the duplicate sets to the institutional herbaria of Berlin (B), the British Museum of London (BM), Kew (K), Leiden (L), Nancy (NCY) and Paris (P), and to the personal herbaria of E. Cosson (now P), B. Delessert (G-DEL), A.P. de Candolle (G-DC), J. Cambessèdes (now at MPU), A. Wigand (now at MB), and probably some others. According to Turrill (1920), 5,000 specimens are preserved in the Paris herbarium (P), with labels reporting localities of collection and accurate descriptions. Other than those indicated above, additional Bertero's Chilean collections are found at A, CGE, CN, E, F, FI, G, GH, KIEL, LE, M, MEL, MO, NY, OXF, PC, SGO, TCD; and those from Juan Fernández Islands at B, F, G, GH, K, L, MEL, MPU, NY, P, P-JU, PC, SGO (Lanjouw & Stafleu 1954, and pers. obs.).

In 1834, Morenhout sent Bertero's Tahitian collections to Alcide Dessalines d'Orbigny (1802–1857) who travelled in South America in 1826–1834 (Orbigny 1834–1847), at Paris in a large crate. As the crate arrived at his destination, it was noticed that it had been opened, and part of its contents was missing. A detailed account on the Tahitian collection made by Bertero and Morenhout sent to d'Orbigny, as well as descriptions of many new species, was published by J.A. Guillemin (1836, 1837). In the first article of the series, Guillemin stated that duplicates of these collections were sent to the Museum of Natural History of Paris (P), to the Royal Academy of Turin (which material has been entirely transferred to the herbarium of the University of Turin, TO), and to the personal herbaria of A.T. Brongniart (now at P) and B. Delessert (now at G-DEL), and other non specified botanists. More research on the distribution of duplicates of Bertero's Tahitian collections is necessary (none cited by Lanjouw & Stafleu 1954). Nevertheless, specimens of his Tahitian incomplete sets were found in Paris (P), Berlin (B, destroyed), Kew (K), and at the Delessert herbarium (G-DEL). Only four specimens of Bertero's Tahitian collections were found at the Turin herbarium (TO-HG), and no reference to them could be found in the correspondence.

Additional references about the distribution of Bertero's collections can be

found in: Anonymous (1833), Lasègue (1845), Caruel (1874), Parlatore (1841, 1874), Saccardo (1895–1901), Urban (1902), Mattirolo (1907), Ciferri (1931), Martelli (1931), Vignolo-Lutati (1931b), Lanjouw & Stafleu (1954), Del Vitto (1986), Matthei (1986), Rodriguez Rios (1986), and Del Vitto et al. (1993).

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ON THE DERIVATION OF THE GENERIC NAME *ILIAMNA* (MALVACEAE)

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Edward Lee Greene is well known as a classics scholar and a botanist with strong opinions. His prowess as a classics scholar is well attested to by his historical work (Greene 1909). His idiosyncratic ideas are too well known to need documentation. But this combination of characteristics leads to some interesting speculations with regard to certain generic names that he proposed. In particular, we deal here with the name *Iliamna*, which he proposed for a genus of western American Malvaceae (Wiggins 1936).

In publishing the name, Greene (1906) did not state how he chose the name or offer any indication of its derivation. Other sources indicate its origin to be unknown (e.g. Gleason 1952; Genaust 1983) or at least mysterious ("Greek, significance obscure": Hitchcock & Cronquist 1973).

Our first considerations of the question took into account Greene's classical learning and led us to the roots *ilyos* (Greek: mud) and *amnis* (Latin: pertaining to a river), which makes a certain amount of sense, since the plants concerned occur in wet habitats. However, it seemed unlikely that Greene would have mixed Greek and Latin roots, so this derivation left us unsatisfied.

We next serendipitously discovered that there is a place name in Alaska, Iliamna, applied to a bay, a lake, a point, a village, and a volcano. The native name of the lake was reported as Oz[e]ro Bol[schi] Ilyamna on the 1852 Russian Hydrog. Dept. Chart 1455. This feature was earlier called Ozyero Shelekhovo on an 1802 Russian map. According to G.G. Martin, USGS, Iliamna is said to be "the name of a mythical great blackfish, supposed to inhabit this lake, which bites holes in the bidarkas [boats] of bad natives" (Orth 1967). The volcano's name was published by the Russians (Orth 1967) as *Sopka Ilymna* (Capt. M.D. Tebenkov, 1852, map # 5). It has therefore been suggested that the Russian name *Ilym* is the root, but this is speculative.

We presume that Greene encountered the name, liked the sound of it, and found an occasion to apply it botanically. But did he apply it because of its sound or because of its meaning? Is the origin of the name Russian or Amerindian? The genus *Iliamna* does not occur in Alaska; its species have their northernmost limit in British Columbia.

We have now learned that what appears to be the "true" derivation of the

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geographical name, which Greene presumably appropriated for botanical purposes. The Dena'ina are an Athabascan people of Cook Inlet and the Alaska Peninsula where the geographical name was used. Their name *Nilamna* (phonetically) was modified by the early Russian colonists into Iliamna. The name derives from two words, *nila* (islands) and *vena* (lake), that is, "islands in the lake." We are grateful to Lydia Black of the Anthropology Department, University of Alaska, Fairbanks, for this information.

Thus, although we now know the derivation of the name *Iliamna*, we remain in the dark as to why Greene chose it as a botanical name. He may have simply liked the sound of it, but it is also possible that he chose it to confound his botanical critics into seeking a classical derivation of a name that did not have classical roots.

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WHAT IS THE WRITER OF A FLORA TO DO? EVOLUTIONARY TAXONOMY OR PHYLOGENETIC SYSTEMATICS?

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ABSTRACT

Plant classification and nomenclature are in a continuing state of flux and heated debate between two opposing schools—**1)** traditional taxonomists supporting "evolutionary" or "Linnaean taxonomy"; and **2)** cladists supporting "phylogenetic systematics" or "cladonomy." While it is a multifaceted controversy that has spanned several decades, relatively little attention has been focused specifically on the ramifications for floristics. The two goals of this paper are **1)** to give special emphasis to the implications of the controversy for the writers of floras, and **2)** to provide an overview of some of the arguments in a format accessible to a diverse audience of botanists interested in floristics. We examine some of the issues we have confronted in our floristic work, discuss how we are attempting to balance the strengths and weaknesses of both approaches, and indicate what we believe is the best, albeit imperfect, approach to the writing of floras at the present time. We argue that, for both practical and theoretical reasons, a modified traditional system (binomial nomenclature, ranked hierarchies) be used in floras (allowing paraphyletic groups but eliminating all polyphyletic groups despite some nomenclatural instability). Further, these floras should incorporate information on newly discovered phylogenetic relationships (even if too preliminary, tentative, or inappropriate for nomenclatural change) and discuss these in appropriate family and generic treatments in order to facilitate as complete an understanding of plant evolution as possible.

RESUMEN

La clasificación y nomenclatura de las plantas está en un flujo continuo y debate ardiente entre dos escuelas opuestas—**1)** taxónomos tradicionales que apoyan la "taxonomía Linneana" o la "evolutiva"; y **2)** cladistas que apoyan la "sistemática filogenética" o "cladonomía." Mientras esta controversia se ha extendido durante varias décadas, se ha prestado relativamente poca atención a las ramificaciones de la florística. Las dos metas de este artículo son **1)** dar un énfasis especial a las implicaciones de la controversia para los autores de floras, y **2)** ofrecer una visión general de algunos de los argumentos en un formato accesible a una audiencia diversa de botánicos interesados en la florística. Examinamos algunos de los resultados que hemos confrontado en nuestro trabajo florístico, discutimos como hemos intentado equilibrar las bondades y debilidades de ambos métodos, e indicamos lo que creemos que es el mejor, aunque imperfecto, método de escribir floras en la actualidad. Argumentamos que, tanto por razones teóricas como prácticas, se use en las floras un sistema tradicional modificado (nomenclatura binomial, sistema jerarquizado) (que permita grupos parafiléticos pero eliminando todos los grupos polifiléticos aunque causen inestabilidad nomenclatural). Además, estas floras deberían incorporar información sobre las relaciones filogenéticas recién descubiertas (incluso si son demasiado preliminares, tentativas, o inapropiadas para cambios nomenclaturales) y discutir éstas en la familia apropiada y tratamientos genéricos para facilitar una comprensión lo mas completa posible de la evolución de las plantas.

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INTRODUCTION

Plant taxonomy is the science that deals with the *identification*, *nomenclature*, and *classification* of plants. The term plant systematics (or systematic botany) is often used synonymously with plant taxonomy (as is done here), but sometimes has the connotation of mainly using recently developed techniques or approaches such as chromosomal studies, electron microscopy, molecular biology, or cladistics to answer questions about plant relationships. From the definition of plant taxonomy it follows that the primary goals of the discipline are to:

1) identify and describe all the various kinds of plants;
2) develop a system of naming plants [e.g., International Code of Botanical Nomenclature (Greuter et al. 2000) or potentially a future version of the PhyloCode (2002)];
3) arrange plants with common characteristics into groups that reflect their evolutionary relationships (Lawrence 1951; Porter 1967; Radford et al. 1974; Jones & Luchsinger 1986; Judd et al. 1999, 2002).

In terms of nomenclature, the goal of plant taxonomy has been to develop a uniform, practical, and stable system of naming plants—one that can be used by both plant taxonomists and others needing a way to communicate precisely and retrieve information about plants. In the words of Stevens (2002), "The value of any naming system is how effectively it establishes conventions that allow people to communicate and to develop their ideas. ..."

Regarding classification, the goal has been to arrange plants with common characteristics into groups that reflect their relationships—in other words, to develop a scheme of classification that is useful—that conveys maximum information and has predictive value. Since the time of Darwin, a primary goal of plant taxonomists has been to reflect phylogeny or evolutionary history in their systems of classification. There are several reasons for this. One is that taxonomists want their classification system to reflect the reality of the evolutionary history of life on earth. Second, a system that reflects evolution should have maximum predictive value and usefulness (since related species should share similarities due to common descent). While this basic evolutionary approach is agreed on by virtually all botanists, in recent years there has been heated debate between two main schools of taxonomists:

1) traditional taxonomists practicing what is sometimes referred to as "Linnaean classification" (Brummitt 1997) or "evolutionary taxonomy." Traditional or evolutionary taxonomists, while attempting to have a classification system based on evolutionary relationships, also try to reflect the amount of evolutionary change undergone by groups. In addition, they try to incorporate other goals, including practicality and stability, into the classification system (see Brummitt

1997 for a detailed discussion of traditional classification). The names Linnaean classification or Linnaean taxonomy (Stuessy 2000; Forey 2001, 2002; Nicolson 2002), are perhaps inappropriate since the system is very different from that established by Linnaeus. In its more recent version it is perhaps better called "evolutionary taxonomy" (Sanders & Judd 2000) or "evolutionary systematics" (Grant 2001b) signifying the attempt to reflect evolutionary relationships. Grant (2001b) uses the acronym TTES "to include the two subschools of traditional taxonomy and evolutionary systematics." When considered from the standpoint of nomenclature, this is a system that incorporates binomial nomenclature (two-part scientific names consisting of a genus name and specific epithet) and a hierarchy of formal ranks (e.g., family, genus, etc.). The nomenclatural application of this viewpoint has been referred to as the "L-code" and its principles are embodied in the International Code of Botanical Nomenclature (Greuter et al. 2000).

2) cladists, whose method of constructing phylogenies is derived from the ideas of the German entomologist Willi Hennig, practicing "phylogenetic systematics" or "cladistic classification" (referred to as "cladonomy" by Brummitt 1997) based explicitly and solely on phylogenetic relationships. In other words, the overriding goal is that classification should reflect the branching patterns of evolution. It should be noted that in a clade-based classification and resulting nomenclature system, there are no formal ranks, including family or genus, and no formal binomial nomenclature (de Queiroz & Gauthier 1992; Lidén et al. 1997; Cantino 1998; Brummitt 2002). The nomenclatural application of this viewpoint has sometimes been referred to as the "P-code" and its ideas are embodied in the PhyloCode (2002).

Currently, classification and nomenclatural systems are in a state of flux between these two main opposing camps—both of which attempt to reflect evolutionary relationships. Those practicing cladistic systematics have made major contributions to our understanding of plant evolution, and have brought about some long overdue changes. In fact, some of their methodology has contributed to a well-recognized revival in taxonomy/systematics. Some of the most evident examples of this are the incredible breakthroughs in knowledge of plant relationships resulting from molecular phylogenetics. It should also be noted that there is significant variation in the extent to which various "phylogenetic" systematists follow all of the implications of the cladistic approach—most, for example, still use binomial nomenclature even though they may disagree with it on theoretical grounds. At the same time, the system of nomenclature (binomial, etc.) and hierarchical classification that has developed over the past 250 years has served and continues to serve the botanical and broader communities well. There are thus positive aspects to both of these approaches.

Because of major differences in philosophy and methodology, the classifi-

cation systems produced by proponents of evolutionary taxonomy and cladistics are often quite different. It is not unexpected then that the two conflicting viewpoints have produced a vigorous and heated debate (e.g., Nixon & Carpenter 2000), which has even been referred to as a "maelstrom" (Benton 2000). The proposed approach of phylogenetic classification has certainly not "mostly been politely accepted by the systematic community" as stated by Schander (1998). In fact, the tone of a few of the articles and discussions (on both sides of the argument) has been surprisingly impolite by the standards of modern scientific discourse, with Webster (2002) referring to the arguments as "an ideological cacophony of bombast and invective." There is a voluminous literature on the subject, including numerous recent articles about the different taxonomic and nomenclatural approaches (e.g., Moore 1998; Stevens 1998; Diggs et al. 1999 (Appendix 6); Mishler 1999; Benton 2000; Cantino 2000; de Queiroz 2000; McNeill 2000; Nixon & Carpenter 2000; Sanders & Judd 2000; Stevens 2000; Stuessy 2000, 2001; Withgott 2000; de Queiroz & Cantino 2001; Grant 2001a, 2001b; Langer 2001; Lee 2001; Pennisi 2001; Berry 2002; Brummitt 2002; Forey 2002; Kress & DePriest 2002; Nicolson 2002; Stevens 2002; Webster 2002). Symposia and workshops have also been held (XVI International Botanical Congress—August 1999; Smithsonian's National Museum of Natural History—March 2001; Hunt Institute for Botanical Documentation—June 2002), and a new system of nomenclature has been proposed (PhyloCode 2002). However, few authors or discussions have specifically addressed the special problems faced by writers of floras (but see Stevens 1998, Sanders & Judd 2000, and Berry 2002). This controversy is actually multifaceted, with many quite different aspects (e.g., are taxon names defined?—Stuessy 2000, 2001, de Queiroz 2000, de Queiroz & Cantino 2001; which system will ultimately be more stable?—Forey 2002) that are beyond the scope of the discussion here. In this paper we are focusing on the implications for floristics.

IMPLICATIONS FOR FLORISTICS

As writers of a flora (the *Illustrated Flora of East Texas* project—Diggs et al. in prep.; www.easttexasflora.org), we and our co-authors are faced with the question of *what type of classification and nomenclatural concepts should be followed in a large regional flora* (ca. 3,300 species or roughly 1/6 the species in North America north of Mexico). We are acutely interested in this question, because as floristicians we must translate and synthesize a variety of types of botanical research, both practical and theoretical, into a form usable by a very diverse audience—one that ranges from professional taxonomists and other scientists to lay botanists, students, and interested amateurs, many of whom are unacquainted with taxonomic methods. In fact, we believe that addressing the needs of diverse users is one of the most important tasks of floristicians. Further, developing a "general-purpose system" that effectively addresses the needs of

multiple users is often considered to be the "historical and continuing function" of taxonomy as a whole (Cronquist 1987). The answer to the question of what type of concepts should be followed varies greatly depending on who one asks. The most conservative voices would say that the traditional system of nomenclature, a ranked hierarchical system of classification, traditional families, etc., should be used due to both theoretical and practical considerations. Some would even argue that clearly polyphyletic traditional families (e.g., Liliaceae in the broad sense) should continue to be used in floras since this is a very useful and practical approach. The most extreme voices on the other side (i.e. extreme cladists) would say that no set categories should be recognized (e.g., no families, no genera; instead, only supportable clades), only monophyletic groups (= a common ancestor and **all** its descendants; Fig. 1) should be given taxonomic recognition (i.e., no paraphyletic groups should be allowed—currently many genera and families are paraphyletic; paraphyletic groups are defined as those containing a common ancestor and some, but not all, of its descendants). Further, the extreme cladists argue that binomial nomenclature should be replaced (since genera have no objective reality, there can be no generic names and hence no binomials; only clade-based names should be used). Interestingly, our previous flora (*Shinners & Mahler's Illustrated Flora of North Central Texas*—Diggs et al. 1999) was criticized by individuals from both extremes. Despite having more information on cladistics (lengthy appendix discussing the issue, discussions in numerous family synopses) than any other regional or state flora we know of (e.g., Hickman 1993; Yatskievych 1999; Rhodes & Block 2000; Wunderlin & Hansen 2000), we were criticized for not applying the cladistic approach throughout the flora. Likewise, some conservative botanists were disturbed by decisions such as lumping some groups (e.g., *Najas* into the Hydrocharitaceae), splitting others (e.g., *Senecio* into *Senecio* and *Packera*), and following an alphabetical rather than a traditional sequence (showing supposed relationships) of families and genera (a logical impossibility since a written flora is linear and evolution is a branching process). One thing to keep in mind when discussing this clash of viewpoints is the realization that any system of classification, nomenclature, and written presentation will be an imperfect reflection of the complexity represented by the evolutionary history of life on earth. In the words of Benton (2000), "phylogeny is real, classification is not." While we now have access to increasingly sophisticated and diverse sources of data, factors such as extinction, an incomplete fossil record, and the complexity of evolutionary processes (e.g., reticulate evolution—Wagner 1954; see discussion below) will prevent us from producing completely accurate phylogenetic reconstructions. Despite these limitations, as floristicians attempting to produce a useful flora, we have to use approaches to classification and nomenclature that best reflect a diverse and complex set of needs.

It is generally agreed that the primary goal of a flora is to allow identifica-

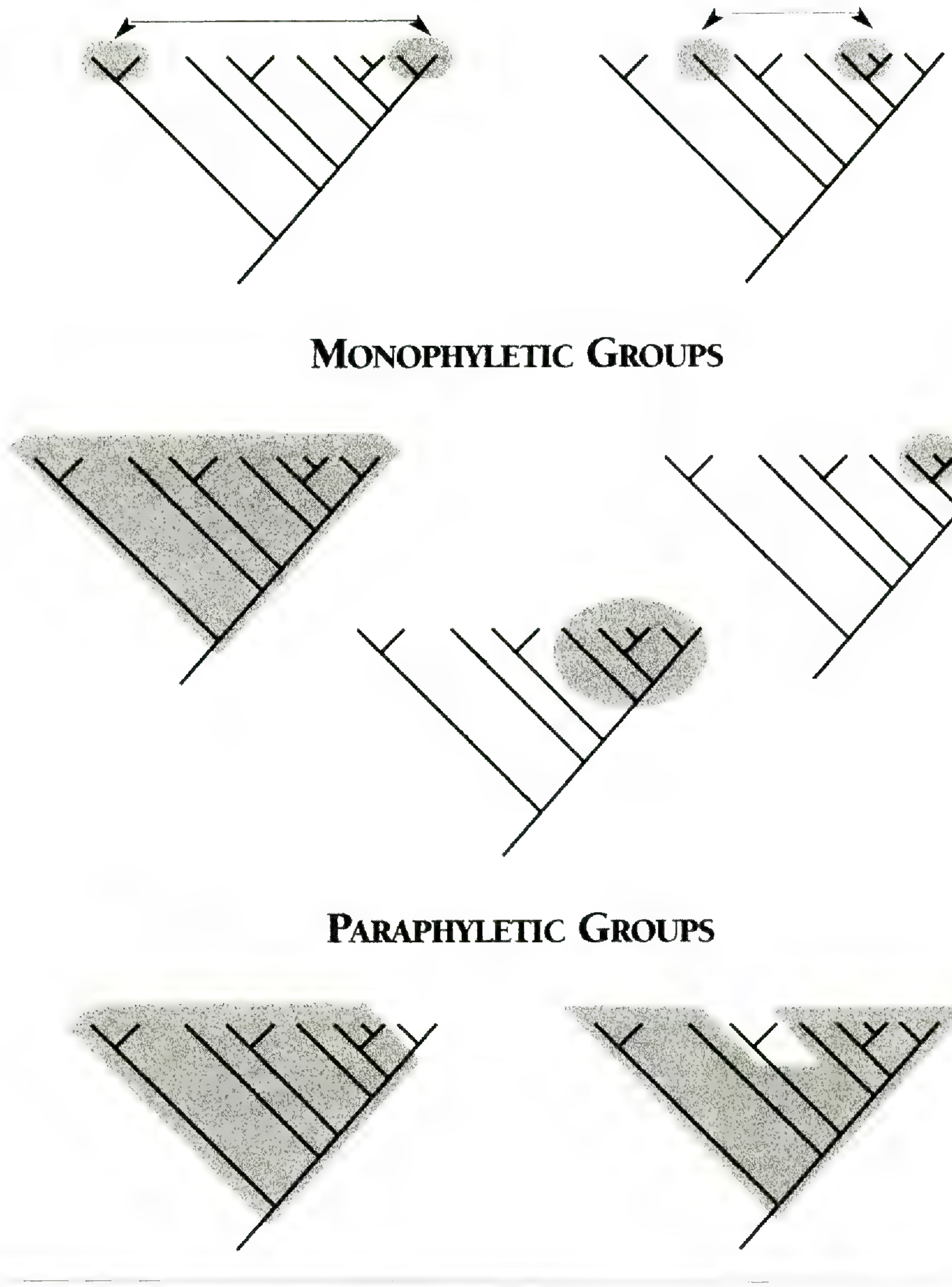


FIG. 1. Diagrammatic representation of polyphyletic, monophyletic, and paraphyletic groups (from Diggs et al. 1999).

tion of the plants treated. However, there are a number of secondary goals. According to Sanders and Judd (2000), these are: **1)** to provide entry into the systematic literature; **2)** to provide thumbnail summaries of the current state of

our knowledge (including systematic, ecological, ethnobotanical, etc.); **3)** to serve as a reference for other professionals; and **4)** to fix the concepts of taxa, especially families and genera, in the minds of users. Generally we agree with these secondary goals, and expended considerable thought and effort in applying them in our previous floristic effort (Diggs et al. 1999). We also agree with Sanders and Judd (2000) that there is a critical need for the collaboration (and probably more importantly cross-training) of floristic, monographic, and phylogenetic researchers. However, we disagree with Sanders and Judd (2000) in *how* to accomplish the fourth of their stated goals. They argue that the methods of phylogenetic classification should be applied consistently in floras (e.g., only monophyletic groups allowed, hence precluding paraphyletic families). We believe that this approach, if inflexibly applied, would hinder the primary goal (of a flora) of allowing effective identification. Further, if all aspects of the cladistic approach are followed (e.g., elimination of ranks and binomial nomenclature) in a flora, we envision significant erosion of this primary goal. The loss of many morphologically coherent and easily recognizable paraphyletic families, the discontinuity in information retrieval due to a radical change in nomenclature, the lack of effective mnemonic devices to replace such widely recognized and practically important ranks as family and genus, and instability in nomenclature (and hence identification) associated with rapidly changing cladograms are a few of the reasons for this concern.

In some cases, floristicians, for practical or historical reasons, are unable to apply even the most important recent phylogenetic discoveries in their floras. For example, the critically important Flora of North America Project, because of the long time span necessary for such a massive multi-volume work, had to adopt a standard years ago (Cronquist system of families)—hence, the Liliaceae (in the broad sense), now known to be clearly polyphyletic, is still being recognized in a forthcoming volume (with an extensive discussion of phylogeny). While we strongly agree with cladists that polyphyletic groups should be eliminated (whenever possible), we disagree with the advisability of eliminating the numerous useful and meaningful paraphyletic groups, particularly at the levels of family and genus (see further discussion below). We would add three other goals to the four (Sanders & Judd 2000) enumerated above: **5)** to address specifically the needs of diverse users (discussed above); **6)** to connect the work of monographers and other researchers to the "consumers of botanical information" (T. Barkley, pers. comm.; Barkley 2000) who need to use these discoveries; and **7)** to use systems of classification and nomenclature that allow meaningful comparisons with other floristic works. In other words, for conservation, biogeographical, ecological, etc. purposes, it should be easy to compare data such as the total number of species, the number of endemics, or the number of introduced species from flora to flora (with the realization that the comparisons will be far from perfect, but useful nonetheless). Ultimately, we somehow

hope to combine several important but not necessarily compatible approaches. We not only want to produce a useful, informative, and user-friendly flora, but also one that accurately reflects evolutionary history (i.e., be phylogenetically informative) and incorporates recent discoveries in botany.

APPROACH TAKEN IN THE *ILLUSTRATED FLORA OF EAST TEXAS*

After considerable thought, discussion with a variety of individuals, and a review of the pertinent literature, we are taking what we hope is an intermediate, albeit somewhat conservative, approach in the *Illustrated Flora of East Texas*. Our goal is to provide maximum information while retaining a practical and utilitarian framework.

Cladistic side

On the ***cladistic/phylogenetic systematics side*** of the argument, a number of our decisions have been influenced by the desire to increase information content and accuracy:

1) We are attempting to provide detailed information on the known evolutionary relationships of various plant groups. A tremendous amount of new information has become available recently (primarily, but not exclusively, as a result of the application of Hennigian principles to molecular data), and as much of this as possible is being included and references provided. For example, in the draft family synopsis of the Lemnaceae (duckweed family), we (Diggs et al. in prep.) have included the following statement.

> Lemnaceae are tiny and extremely reduced morphologically making it difficult in the past to determine the phylogenetic relationships of the family. Kvacek (1995) suggested that the fossil genus *Limnobiophyllum* is a fossil link between Araceae and Lemnaceae, and Stockey et al. (1997), using a cladistic approach and material of *Limnobiophyllum*, concluded that *Pistia* (a free-floating member of the Araceae) plus *Limnobiophylum* and Lemnaceae form a monophyletic group. Indeed, this linkage of Lemnaceae to Araceae goes back over 175 years (Hooker and Brown in Smith 1824; see discussion in Les et al. 2002). In addition, molecular studies have linked *Lemna* with *Pistia* (Araceae) (Duvall et al. 1993b) or more recently to Araceae subfamily Aroideae (French et al. 1995). In fact, the Lemnaceae is considered by many authorities to have evolved from within Araceae (JACK-IN-THE-PULPIT family) by extreme reduction, and it has been suggested that Lemnaceae be reduced to a subgroup within a more inclusive Araceae (Mayo et al. 1995, 1997, 1998; Stockey et al. 1997). From a cladistic standpoint, Araceae (without Lemnaceae) are paraphyletic and inappropriate for formal recognition.
>
> Even where very preliminary information is available, we have included and referenced it in an attempt to foster a better understanding of evolutionary relationships.

2) Also on the cladistic side (and on that of most other plant taxonomists), we are rejecting all clearly polyphyletic groups, even when these are practical and of long-term or wide usage. The best example of this is the Liliaceae (lily family) sensu lato (in the broad sense). Extensive morphological and molecular data

now clearly indicate that as broadly conceived, this family is a heterogeneous mixture based on superficial similarities in flower structure (e.g., Fay et al. 2000; Rudall et al. 2000b). In fact, recent molecular studies (e.g., Chase et al. 2000) have shown that species traditionally treated in the Liliaceae should be placed in at least four different *orders*. As a result, we are recognizing 14 separate families (all previously treated in the Liliaceae) for East Texas. However, from the standpoint of usability, we are incorporating a table in the Liliaceae (narrow sense) family treatment that clearly indicates in what family the genera formerly included in the Liliaceae (broad sense) are now placed. Furthermore, in the main key to families, as many as possible of the liliaceous (broad sense) families will be clustered together and clearly indicated. Likewise, the genus *Nolina* (bear-grass) and its relatives, which have often been included in the Agavaceae (agave family), are now known to not be closely related to that family and we are excluding them. In a draft family synopsis we (Diggs et al. in prep.) say,

> In the past, taxa included here in the Nolinaceae were sometimes included in a broadly conceived Liliaceae (e.g., Kartez 1999) or often in the Agavaceae (e.g., Correll & Johnston 1970; Diggs et al. 1999; Verhoek & Hess 2002 following Cronquist 1988) based on certain morphological similarities. However, recent evidence suggests that the Agavaceae and Nolinaceae are not closely related and should be recognized separately (Dahlgren et al. 1985; Eguiarte et al. 1994; Bogler & Simpson 1995, 1996; Kubitzki et al. 1998; Chase et al. 2000). Molecular evidence indicates that Nolinaceae is closely related to Convallariaceae and Ruscaceae, and some studies (e.g., Chase et al. 1995a; Chase et al. 2000; Fay et al. 2000) have suggested that the Nolinaceae should be included in the Convallariaceae. Following such preliminary studies, Judd et al. (1999), lumped the Nolinaceae into the Convallariaceae. On the other hand, Rudall et al. (2000a) and Judd et al. (2002) included the Nolinaceae in a broadly interpreted Ruscaceae. However, there has been disagreement in molecular analyses of the family and its presumed relatives (e.g., Rudall et al. 2000a; Yamashita & Tamura 2000). Since the Nolinaceae appears to be a well-defined monophyletic group (Bogler & Simpson 1995, 1996), and until the phylogeny of this complex is clarified and the nomenclature more stable, we are recognizing it as a distinct family.

Hopefully, such explanations will allow users to see that the understanding of plant relationships is still changing and improving. With such insights, we hope that non-taxonomists will be less resistant to *needed* nomenclatural changes.

3) Again on the cladistic side, when *established useful family concepts are not excessively distorted*, we are lumping small groups whose relationships have now become clear. For example, the monogeneric family Najadaceae (the genus *Najas*) is now known to be derived from within the Hydrocharitaceae (R. Haynes, pers. comm.; Shaffer-Fehre 1991; Les et al. 1993; Les & Haynes 1995; Haynes et al. 1998; Haynes 2000). Including *Najas* in the Hydrocharitaceae more accurately reflects evolutionary history, yet does not substantially modify the concept of the Hydrocharitaceae nor distort it beyond the bounds of usability. We are therefore following several recent floristic treatments (e.g., Thorne 1993; Diggs et al. 1999) in lumping *Najas* into the Hydrocharitaceae.

4) Our families, genera, and species are arranged alphabetically. Some very traditional taxonomists want "related" families placed together in the linear sequence physically required of a book. However, the complex branching pattern of evolution does not follow such a linear form and thus any linear sequence is highly arbitrary and distorts actual evolutionary relationships. An easy to use alphabetical sequence, while not reflecting relationships, at least does not distort them. In addition, an alphabetical arrangement allows quick and easy access to the material so arranged.

Evolutionary taxonomy side

On the ***evolutionary taxonomy*** side of the argument, a number of our decisions have been influenced by both practical and/or theoretical considerations:

1) We are continuing to use the system of nomenclature that has developed over the past 250 years (International Code of Botanical Nomenclature—Greuter et al. 2000). This (particularly the use of binomials) is an eminently useable system that addresses the needs of an audience far broader than the taxonomic community ("the consumers of botanical information"—T. Barkley, pers. comm.; Barkley 2000). We believe that eliminating it would cause great confusion among the many non-taxonomists who use plant names. In fact, it is likely that if plant taxonomy went to a specialized non-binomial, clade-based system, some separate static system of "accepted plant names" would be developed by the horticultural community or other user groups (e.g. agricultural, ecological, conservation). Such a move would both marginalize plant taxonomy and ultimately result in a nomenclatural system with much less information content than at present. This practical consideration may well be one of the most important reasons for maintaining our current system of classification and nomenclature. In fact, even those developing the PhyloCode (2002), the nomenclatural system being produced by phylogenetic systematists, have not yet come to grips with what to do regarding the naming of "species." It is interesting to note that Stevens (2002) has argued that binomials have been used so long and so widely (across many cultures and in many contexts) because they are inherent in human perception—in other words, having such a two word nomenclature system may be built into the organization of our nervous systems. Nixon and Carpenter (2000) in a similar vein suggested that, "Our natural form of communication (even as evidenced by the common human binomial system of naming ourselves) is clarified by the use of ranks and binomials." Likewise, anthropologist Brent Berlin (1992) noted that there are widespread cross-cultural regularities in the classification and naming of living organisms by people in traditional, nonliterate societies—these systems more closely approximate Linnaean binomials than clade-based nomenclature. Further, when the diverse users of a flora are considered, a radical shift in the system of nomenclature used seems particularly ill-advised, especially at a time when the public needs to be brought closer

to, rather than pushed further away from, an appreciation and understanding of botany. Indeed, these ideas raise questions about a "dominant" code (T. Barkley, pers. comm.) of nomenclature. Undoubtedly, a P-code will be used, but it remains to be seen how widely such a system will be accepted by the diverse users of botanical information—the L-code may continue to be used as the primary or dominant code by the user community long after a functioning P-code (presumably the PhyloCode) is finalized.

2) While many taxonomists have long realized that the traditional ranked categories (e.g., family, genus) are not used consistently and are simply human constructs (unlike species which have some biological reality), they do, however, provide important mental pegboards or mnemonic devices to allow a practical way to arrange our thinking. As Stevens (2002) has said, "Hierarchical naming systems pervade our whole language and thought." We are thus retaining a traditional ranked hierarchical system of classification (in other words, groups of organisms arranged in a hierarchy of categories—genus, family, etc.). While there are evident problems with such a system, the "cornucopia of categories" (Colless 1977) resulting from a cladistic approach does not seem to be an overall improvement in communication, and in fact seems less suited to human mental abilities. In a clade-based system, a particular species is in dozens if not hundreds of successively larger clades—how does one choose which of these clades to use in real-world situations (e.g., floras, textbooks). This point seems to be particularly crucial to writers of floras—unless all genera or even species are to be arranged alphabetically, which would be extremely user unfriendly, some higher level organization must be agreed upon. It seems clear that some *arbitrary convention* to replace the convenience of currently used families would have to be developed for use in a completely clade-based system—in other words, someone would arbitrarily have to decide which of the innumerable clades to recognize. Otherwise, there would be no practical way to group species in floras (now grouped in families and then genera) and no groups to refer consistently to when comparing different floras, etc. In fact, for practical reasons many cladists still use traditional ranks such as family and genus (e.g., Judd et al. 2002), despite stating that "one logical step would be to eliminate ranks altogether." Currently, only three words (e.g., Fagaceae, *Quercus alba*) are needed to communicate a great deal of information about a particular organism and these are used consistently by botanists. In our flora for example, genera are being arranged alphabetically under alphabetically arranged families. Does this mean that these families are viewed as somehow being equivalent?—of course not. They are, however, effective means of conveying information. As stressed by Stevens (2002), if we are going to be able to effectively communicate, "...conventions will be needed. To paraphrase Linnaeus, without convention, all is chaos." As Stevens (2002) so clearly pointed out, even early botanists (e.g., Linnaeus, Bentham) were quite concerned about effective communication.

What would be the system of organization under a system of unranked clades and how could consistency (and thus communication, information retrieval, comparability, etc.) be assured in different floras, textbooks, etc.? Ultimately, some arbitrary convention (not unlike our current family system) would seem to be required. To be fair, it should be noted that the PhyloCode (2002) is not yet complete and nomenclatural conventions will have to be worked out in the future. Whatever system is ultimately settled upon, the conventions used should take into consideration a variety of factors (e.g., accuracy of information conveyed, effectiveness of communication to a broad range of users, compatibility with the organization of the human nervous system, etc.).

3) Furthermore, we are *not* rejecting paraphyletic groups (e.g., families). For example, it now seems clear (as stated above) that the Lemnaceae (duckweed family) arose from within the Araceae (arum family), which is thus paraphyletic. It seems more reasonable to us to continue to recognize both easily distinguishable families, and unambiguously state in discussions associated with both what the evolutionary relationships between the two are. Clearly the duckweeds have undergone extraordinary morphological and genetic divergence in adapting to an aquatic environment—so much so that the question of their ancestry was only recently resolved. To lump the two families and have their genera mingled in a taxonomic treatment accomplishes little and seems to result in a loss of clarity and evolutionary information. As currently recognized, both families have significant morphological coherence and thus recognition and predictive value—together, they are a mixture of two very different types of morphology. A similar example can be seen with the Cactaceae. That family has recently been shown to have evolved from within the Portulacaceae (Hershkovitz & Zimmer 1997; Applequist & Wallace 2001). Lumping the two families in a floristic treatment would only obscure the many differences between these useful and easily recognizable groups. This reflects the view of evolutionary taxonomists, who while attempting to have a classification system based on evolutionary relationships, also try to reflect the amount of evolutionary change undergone by groups (Fig. 2). Evolutionary taxonomists argue that classification is "... more than just branching patterns of evolution" (Stuessy 1997). Brummitt (2002) stressed Mayr's (1995) observation that Darwin indicated evolutionary classification depends on two factors, descent and modification, not descent alone. To use a well known animal example, because birds are so different from other vertebrates (e.g., fly, have feathers, etc.), they are treated as a different class of vertebrate even though they are known to have evolved from within the paraphyletic class known as reptiles (Fig. 3). From the practical standpoint, there are numerous other useful and evolutionary meaningful paraphyletic groups. Examples include the Araceae, Capparaceae, Clusiaceae, Moraceae, Portulacaceae, etc. Radically changing their circumscription (e.g.,

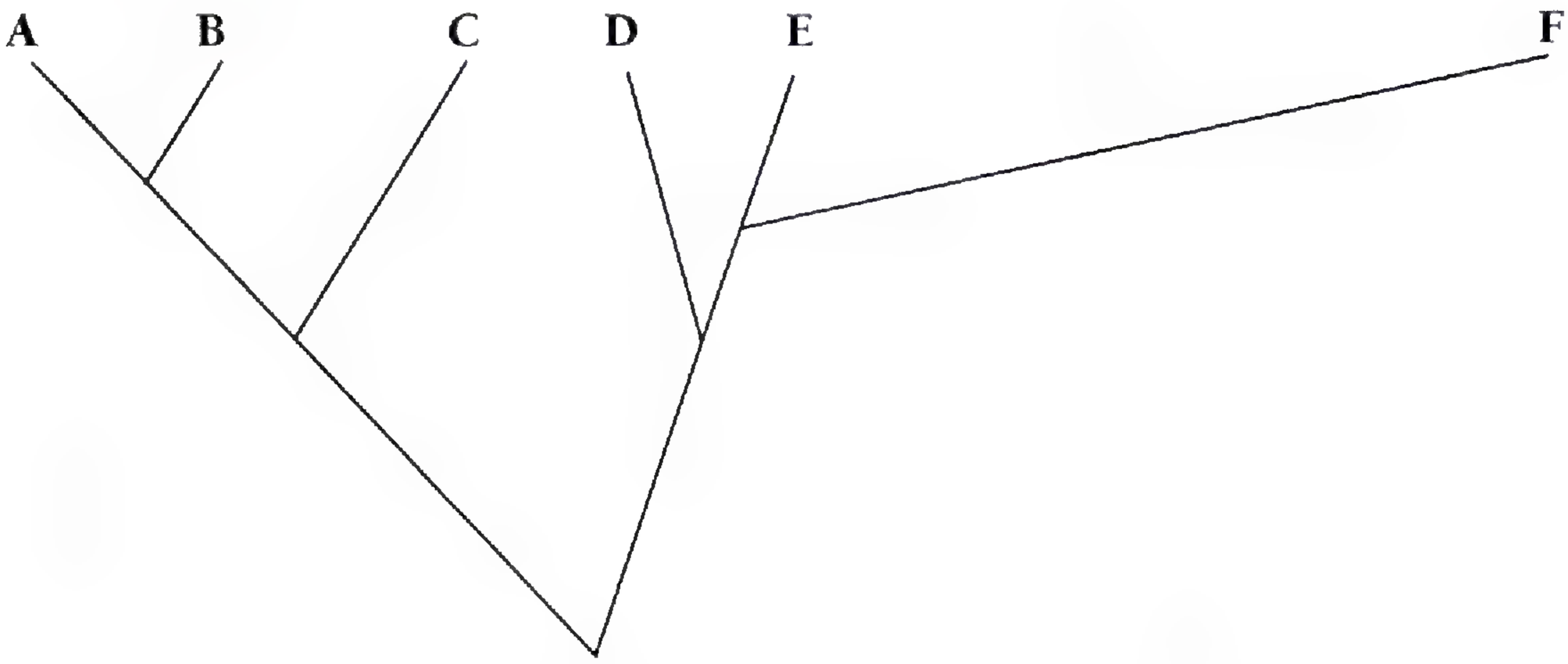


FIG. 2. Phenetic distance diagram; horizontal distance between species indicates phenetic difference. Note that species F, while most closely related phylogenetically to species E, is quite different in terms of phenetics (from Diggs et al. 1999).

adding Cactaceae to Portulacaceae, Podostemaceae to Clusiaceae, or Lemnaceae to Araceae) results in confusion and a loss of information. This risk of confusion is particularly problematic if the same name is variously used to include quite different sets of species (e.g., Portulacaceae in the narrow sense or in the broad sense including Cactaceae). The risk of a nomenclatural "train wreck" (Stevens 2002) is a troubling possibility. Very different uses of the same names "will be decidedly unsettling for society and perhaps damaging for our discipline" (Stevens 2002). Unfortunately, taxonomists have long had the reputation of changing names without regard for the implications, and great care needs to be taken to avoid non-essential changes. Grant (2001b) stressed that splitting up paraphyletic groups (e.g., genera such as *Gilia* or *Linanthus*) obscures relationships and multiplies generic names where one would be sufficient. Does the splitting up of recognizable and well known genera really best serve the broad constituency of users (keeping in mind that professional taxonomists are a small fraction of the users of scientific names)? Changes in classification at the generic level are particularly significant because of the resulting changes in scientific names.

Further, Brummitt (1997, 2002) has argued that paraphyletic groups are inevitable. He goes on to say that any genus "must have originated from a species in another genus, which is thus paraphyletic." The same logic applies at other levels in the hierarchy, including the species level. Species, unlike other categories in our hierarchical system of classification, have some objective biological reality (e.g., Rieseberg & Burke 2001). However, if a small subgroup of a species differentiates or specializes enough to become a distinct entity, the original species is thus rendered paraphyletic even though it may still be a reproductively isolated or otherwise distinct group. Species can be excluded by defi-

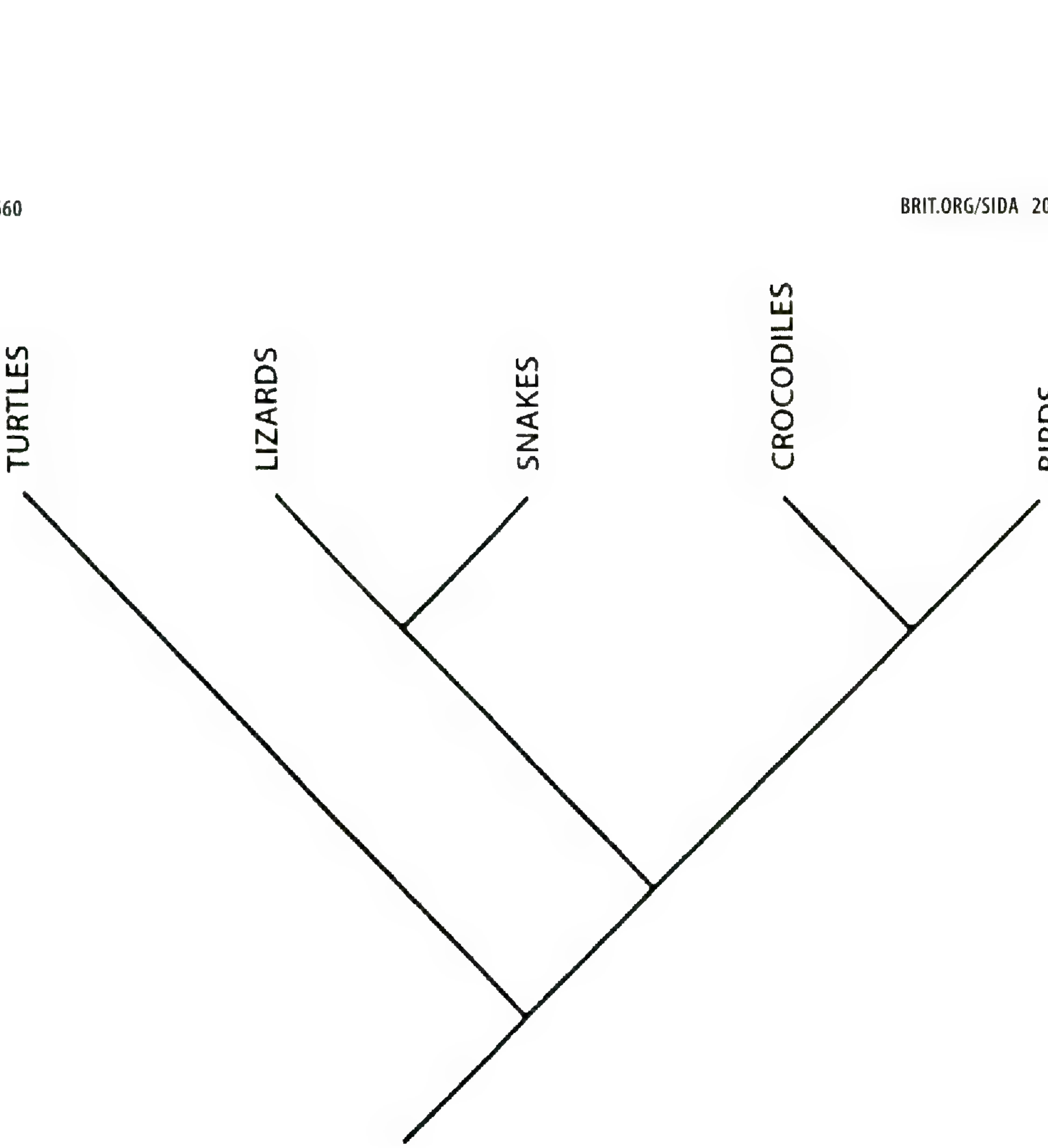


FIG. 3. Dendrogram showing relationships of some vertebrate groups. Note the paraphyletic nature of the "Reptilia" (from Diggs et al. 1999).

nition as not being paraphyletic (Sanders & Judd 2000) as done by some cladists, but in reality, by standard use of the term, they are often paraphyletic (see Mishler 1999, 2000). As Brummitt (2002) noted, the abandonment of species "seems to me to be a necessary logical extension to abandoning all other ranks" (Brummitt 2002). Further, Rieseberg and Brouillet (1994) argued that based on the modes of speciation known to occur in plants, paraphyletic species are common. In the words of Sosef (1997), "When a single diaspore [e.g., seed] accidentally reaches an isolated habitat and its offspring gradually changes (a linear process) and produces a new species, nothing 'happens' to the parent species." The new species thus renders the unchanged previous species paraphyletic. Ultimately, paraphyly thus seems unavoidable. An excellent example of this problem can be seen in the California tarweeds (genus *Raillardiopsis*) and the Hawaiian silverswords (genera *Argyroxiphium*, *Dubautia*, and *Wilkesia*) in the Asteraceae. It now appears (Baldwin et al. 1991) that *Raillardiopsis* (which had previously been considered a "phenotypically conservative genus of two nearly identical species") was the "ancestral genetic source" for the endemic and extremely morphologically divergent Hawaiian silversword alliance. *Raillardiopsis*

is thus clearly paraphyletic, even though its two species are "nearly identical." When taken to its logical extreme, the failure to recognize paraphyletic groups would require the rejection of many useful groups (e.g. tarweeds). In animal taxonomy, this means the rejection not just of the group Reptilia (which gave rise to birds), but also Amphibia (which gave rise to reptiles), and Pices (which gave rise to Amphibia). Anyone understanding the basics of evolution realizes that fishes gave rise to amphibians. Does that make the class Pices any less useful a concept? Likewise, the capers (Capparaceae) gave rise to the mustards (Brassicaceae)—both families are still useful and meaningful concepts that can help us understand evolution and organize our thinking. Cronquist (1987) stressed the need for paraphyletic groups, indicating that both evolutionary relationships and the amount of evolutionary divergence among taxa is important. He said that "the reasons for this belief are rooted in the historical and continuing function of taxonomy as a general-purpose system of classification that can be used by all who are concerned with similarities and differences among organisms"—in other words, diverse users of botanical information. While we believe it is critically important for paraphyletic groups to be clearly distinguished from monophyletic groups, the usefulness of paraphyletic taxa (e.g., effective communication, recognition of divergence, morphological similarities, etc.) seems to be an important consideration.

4) Additionally, there are many cases where it is not yet clear what should be done cladistically. Thus in these cases we are retaining traditional usage until more information is available. For example, it is very likely that such families as the Lamiaceae (mint family), Verbenaceae (vervain family), and Scrophulariaceae (figwort family), as traditionally conceived, will have to be changed substantially. However, if we had to finalize treatments of these families today for our flora (which fortunately does not have to happen since these dicot groups will be treated in Vol. 2 of the *Illustrated Flora of East Texas* to be published in 2008), we would probably follow the traditional circumscriptions and accompany them with substantial explanations. The reason is that adequate research has not yet been done on these groups to provide answers that are definitive enough to warrant major changes in classification and nomenclature. In the words of Berry (2002), "it will be some time before our sampling of organisms at the molecular level will be good enough that we can get an adequate idea of relationships across the entire span of biological diversity." Further, it does not seem desirable that classification (and nomenclature) should change with every new cladistic discovery—do we really want nomenclature that "depend[s] rigidly on the particular cladogram favoured at the moment" (Benton 2000)? Indeed, Sanders and Judd (2000) discuss the criteria for accepting revised classifications. Before making major nomenclatural changes, there should be substantial taxonomic evidence, to avoid more of the numerous ex-

amples where initial cladistic hypotheses have proven to be wrong. For example, in the past, some authorities have suggested major changes in family circumscription based on preliminary information (e.g., lumping the Apiaceae (carrot) and Araliaceae (aralia) families—Judd et al. 1994; Zomlefer 1994), only to have more detailed work (Plunkett et al. 1996 [1997]) clarify the situation and indicate that the families should be maintained in nearly their traditional circumscriptions. According to Plunkett et al. (1996 [1997]), the approach taken by Judd et al. (1994) "hides rather than resolves the difficulties in Apiales." Likewise, Downie et al. (2001) did not lump the Araliaceae. Another example is the genus *Trillium*—it has often been treated in the Liliaceae in the broad sense (e.g., Correll & Johnston 1970) or based on early phylogenetic analyses in the Trilliaceae (e.g., Zomlefer 1996; Tamura 1998d; Judd et al. 1999). However, more recent phylogenetic analyses (e.g., Rudall et al. 2000b) indicate that it belongs in the Melanthiaceae. There are also instances where the best and most recent evidence conflicts. A number of molecular studies have suggested that Burmanniaceae (previously considered to be related to Orchidaceae) is in the Dioscoreales and thus more closely related to such families as Dioscoreaceae and Nartheciaceae than to Orchidaceae (which is in order Asparagales) (Chase et al. 1995b; Caddick et al. 2000, 2002; Chase et al. 2000). In contrast, other recent molecular research including more genera than previously sampled, indicates that the family (minus the superficially similar but unrelated genus *Corsia*) plus Thismiaceae is in a relatively isolated position "not closely aligned with either the Dioscoreales or the Orchidaceae" (Neyland 2002). Writers of floras are thus faced with having to judge which cladistic studies to accept and when there is enough evidence to use the new discoveries in floristic treatments. At the same time, writers of floras must avoid the instability and confusion that would result from changing classification and nomenclature with every new study published. Furthermore, recent tests (Grant 2001a) of the accuracy of cladograms when compared with known phylogenies (e.g., domesticated and experimental plant groups with known pedigrees), raises questions about bas ing classification and nomenclature solely on cladistic methodology. Grant (2001a) demonstrated that the "cladograms of the four plant groups [tested] all differ in significant details from the known pedigrees." Particularly important is his following point: "It is also recognized by all evolutionary systematists and most cladists that reconstructed phylogenies are unverified hypotheses. Some cladists, however, seem to regard their cladograms as real phylogenies." He (Grant 2001b) also indicated that "Molecular cladograms are very good indicators, but we should not lose sight of the fact that the groupings they indicate are molecular clades, not taxa." A recent paper by Rydin et al. (2002) on Gnetales is particularly telling in this regard. Depending on which molecular analysis was used, the phyogenetic position of Gnetales differed significantly. According to Rydin et al. (2002), "It is becoming increasingly clear that the understanding of

molecular evolution and its impact on phylogenetic studies is poor. Nucleotide data alone might not be able to solve phylogeny and evolution of this ancient, once rapidly evolving group, and attempts to do so should include a comprehensive taxon sampling and several genes. Molecular data can definitely be misleading, and by ignoring that, science will not progress." From the standpoint of a floristician, while recognizing the obviously valuable contributions made by molecular systematists and cladists, careful thought must be given to avoid accepting major, sometimes disruptive (and occasionally incorrect) classification and nomenclature changes prematurely.

5) Finally, we are *not* accepting some aspects of phylogenetic classification (particularly strict monophyly—sometimes and perhaps better referred to as holophyly) since there are **serious *theoretical* problems** that make it at least partially incompatible with the reality of the natural world (however, see Freudenstein 1998 for an opposing viewpoint). Brummitt (2002, pers. comm.) has stressed the importance of these theoretical considerations, and in terms of the implications for floristics, these are perhaps as important as or even more important than the purely practical considerations. **One of the most serious problems** (referred to as a "fatal one" by Stuessy 1997) is that cladistics uses only branching information in phylogeny. In contrast, evolution is a complex process including such phenomena as asexual reproduction, progenitor-derivative species pairs, lateral gene transfer, polyploidy, and reticulate evolution (the latter resulting from hybridization between species and subsequent speciation in the offspring) (Rieseberg & Brouillet 1994; Sosef 1997; Stuessy 1997). These complexities cannot be accommodated in a classification system requiring only strict monophyletic groups and dichotomous branching. In the words of Stuessy (1997), "... simple dichotomous branching diagrams cannot do justice to the real world of higher plant phylogeny." An excellent example can be seen in the reticulate evolution of the fern genus *Asplenium* as discussed in the classic paper by Wagner (1954). In this case, the hybrids between two parental species become reproductively isolated (and thus constitute a separate new species). Another example can be seen in the Triticeae (*Elymus*, *Hordeum*, *Secale*, *Triticum*, and their relatives; Poaceae). This tribe has an extremely complex evolutionary history involving hybridization, polyploidy, and reticulate evolution (Barkworth 2000; Mason-Gamer & Kellogg 2000). Both of these examples emphasize that some evolutionary relationships are simply impossible to reflect accurately in a system requiring strict monophyly and only dichotomous branching. As Brummitt (1997) indicated, "No matter how much we may long for all our taxa to be monophyletic, if we are considering the whole evolutionary process, it is a logical impossibility." Another way of stating the problem is that simple branching patterns are unable to reveal all significant dimensions of phylogeny (Stuessy 1997).

A second theoretical problem with strict monophyly is that "only the tips

of evolutionary branches can be classified" (Meacham & Duncan 1987) in such a system, and "Species at the interior nodes of the tree must remain unclassified." Not including ancestral species, some of which may well have survived to the present, seems untenable. However, including them leads cladists insisting on strict monophyly (holophyly) down the path of the "telescoping" or "snowball" effect (also known as the "taxonomic black hole") where more and more organisms have to be included in a futile attempt to reach the mythical (and impossible to reach) strictly monophyletic group (Sosef 1997; Brummitt 2002; but see Stevens 1998 and Sanders and Judd 2000 for a different viewpoint). Ultimately, the whole Tree of Life (2002) would have to be included in one giant monophyletic group. In the words of Brummitt (2002), "If we are classifying all the products of evolution, i.e., the whole evolutionary tree of life, every taxon we recognise must make another taxon paraphyletic. That is a simple logical fact. It is obvious to most people that if you cannot have paraphyletic taxa, you cannot have a classification showing anything beyond one original species, genus, family, etc." He points out that *if ranks are to be used* (which seems essential from the standpoint of practicality), paraphyly is unavoidable (Webster 2002 referred to this as "Brummitt's Paradox"). Thus, there is a "fundamental incompatibility between Linnaean classification and a system of monophyletic taxa, or clades" (Brummitt 2002). In other words, including all extinct species would mean that no monophyletic groups (or only one huge one) could be recognized. From this standpoint, "extinction [and our lack of knowledge about extinct species] is the saving grace of phylogenetic systematics" (T. Barkley, pers. comm.). *Importantly, "Brummitt's Paradox" means that simply converting cladograms into Linnaean nomenclature is impossible.* Ultimately, this means that in order to have strict monophyly, phylogenetic systematists must develop a rankless system such as the PhyloCode. While some modern phylogenetic systematists continue to recognize families for practical/pedagogical reasons (e.g., Judd et al. 2002), if carried to its logical conclusions, cladistics would mean that these families (particularly if extinct taxa are considered) would be telescoped into ever larger groups.

A third related theoretical problem demonstrates that a strictly monophyletic system *using Linnaean ranks* is incompatible with evolution (Brummitt, pers. comm.). As Brummitt (2002) indicated, "...I think we all understand that evolution has continually been throwing up greater and greater diversification of plants and animals, and yet the cladistic idea of classification requires that all successive descendant groups have to have lower and lower taxonomic rank. Something which has evolved from within one genus must have a rank lower than genus. Is this view of taxonomy really a sensible idea? How can we apply lower and lower ranks when evolution is producing wider and wider variation? In a clade-based classification you can go on extending your clades as evolution progresses *ad infinitum*, but if you are using a traditional taxon-based classification you can't keep on giving them lower ranks." Without paraphyly, the use

of ranks in a monophyletic system therefore is simply not workable (hence the advocacy of a rankless Phylocode by some cladists). This problem seems to clearly indicate the logical impossibility of a rank-based, strictly monophyletic system.

A fourth theoretical problem is that our current methodology of obtaining phylogenetic trees is based on a series of assumptions and indirect evidence (e.g., character polarity, choice of outgroups, etc.) (Stuessy 1997), as well as mathematical algorithms (e.g., parsimony) that result in trees that "are almost always inappropriate as phylogenetic hypotheses in any but the most general sense" (Zander 1998). Zander (1999) further indicated that, "Selecting one phylogenetic hypothesis of several or many reasonable alternatives as 'best' and presenting it as a reconstruction cannot provide a probabilistic or dependable basis for action." Is the pursuit of the shortest tree the ultimate goal of systematics? The answer seems clearly to be no, since there are well-documented nonparsimonious pathways of evolution (Stussey 1997). Thus, totally tying classification and nomenclature to such a system seems problematic. A final concern that follows from this is that the current classification and nomenclature system is independent of a particular approach. As stated by Jørgensen (2000), "A problem inherent with the system proposed by Cantino & de Queiroz (2000) [PhyloCode] is that their nomenclature depends upon a specific way of taxonomic thinking, i.e., nomenclature is ruled by the taxonomic system. This probably reflects that they are as convinced of their taxonomic system as Linnaeus was of his, but, please, at least consider the possibility that new taxonomies may evolve. Should we then change the nomenclatural system each time?"

FURTHER IDEAS AND DISCUSSION

The following ideas and quotes seem to provide substantial insight into the controversy. Because of both philosophical and practical implementation problems, Brummitt (1997) pointed out that while the controversy should be debated, it seems unlikely that "Linnaean classification" will soon be abandoned. Brummitt (1997) suggested that both a "Linnaean classification" system and a clade-based phylogeny are desirable because they have different functions. He argued that both be allowed to exist side by side and that the nomenclature of the two should be easily recognized as different (Brummitt 1997). In summarizing his ideas he stated, "... we should not follow traditional practices just because they are traditional, but neither should we adopt new ideas just because they are new. We need to understand the possibilities and appreciate the different objectives and functions of the different options. In the meantime, it seems to me and to many others that the compromise of maintaining Linnaean classification but trying to eliminate paraphyletic taxa is nonsensical and should be abandoned before any more damage is done to existing classifications and nomenclature." Lidén et al. (1997) indicated, "If applied consistently, Phyllis [= Lidén et al. term for

nomenclatural application of cladistics] will cause confusion and loss of information content and mnemonic devices, without any substantial scientific or practical advantage. ... any attempts to make Phyllis formal would be disastrous. We can find no conclusive, valid arguments against keeping the body of our current system intact." Sosef (1997) stressed the same idea saying, "The quest for monophyletic taxa and the splitting of former paraphyletic ones should halt immediately, as they unnecessarily deteriorate classifications which will often prove to be valid."

An interesting point was also made by Stuessy (1997) when he said, "... in this urgent climate of seeking to inventory the world's biota (Anonymous 1994), and requesting funds from the rest of society to do so, it would be highly counterproductive to simultaneously recommend whole-scale change of names of organisms for any reason." In the words of Paul Ehrlich (2002), who was stressing the need for taxonomists to focus on conservation activities, "Others spend their time trying to replace the functional Linnaean system for general communication about organisms with one based on estimates of times of phylogenetic divergence; a sillier enterprise is hard to imagine. ..."

While recognizing it is not perfect, Wheeler (2001, and quoted in Forey 2002) noted that Linnaean nomenclature "is stable enough to say what we know, flexible enough to accommodate what we learn; independent of specific theory, yet reflective of known empirical data; compatible with phylogenetic theory, but not a slave to it; particular enough for precise communication, general enough to reflect refuted hypotheses."

While strongly supporting a cladistic system, Welzen (1998) also noted that a compromise between the two types of classification is impossible. He also understood that because of practical reasons it is impossible to abandon Linnaean classification "... because too few cladograms are available to replace the existing system with a complete phylogenetic classification. Moreover, quite a few cladograms will not be that trustworthy due to the many homoplasies [result of convergent evolution] that have evolved; they will therefore, provide an unstable classification at best." Welzen (1997) went on to say, "I think, therefore, that the best solution is to choose the second option that Brummitt (1997) provides in his paper, namely, 'retaining Linnaean classification, with paraphyletic taxa, but developing alongside it an independent clade-based dichotomous system with its own separate nomenclature.'" Recently, Brummitt (2002) indicated that, "If people insist on monophyly, the clade-based PhyloCode will provide a logical solution. If they want to use the traditional ranks, the answer is very simple: recognise paraphyletic taxa." Brummitt (1997) made what seems to be a very reasonable suggestion: "Our task is to produce an optimally practical classification, and indicate which genera have evolved from which other genera, which families from which other families, and so on."

Indeed, recently it seems to have become clearer that two separate systems

will be necessary (Cantino 2000; Brummitt 2002). Years ago, Woodger (1952, and quoted by Brummitt 2002) concluded that, "The taxonomic system and the evolutionary phylogenetic scheme are quite different things doing quite different jobs, and only confusion will arise from identifying or mixing them." Similarly, it has been argued more recently that to attempt to apply cladistic rules (e.g., elimination of all paraphyletic groups) on the traditional Linnaean system is a logical impossibility (Brummitt 2002) or at minimum highly detrimental (see discussion above). According to Brummitt (2002), "I believe there is no middle way which will combine universal monophyly with formal Linnaean ranks, and this is now increasingly being realized." However, while it is becoming more widely recognized that the two systems are incompatible (but see Stevens 2002), there is clearly value in having a strictly phylogenetic system of classification. It would thus seem that the most reasonable course for the near term would be to allow the concurrent existence of two separate systems—Linnaean and phylogenetic. The Linnaean system would retain hierarchical ranks, binomial nomenclature, and paraphyletic taxa, while the phylogenetic system (e.g., PhyloCode) would recognize monophyletic clades (but have neither ranks, binomial nomenclature, nor paraphyletic taxa, and possibly not even species). Because of practical considerations, the Linnaean system will probably continue to be the "dominant" system used (nearly exclusively) to communicate information about plants by scientists outside of systematics (e.g., ecologists, horticulturalists, conservationists, etc.) and by the general public. The phylogenetic system will make contributions among systematists and others attempting to further understand the evolutionary history of life on earth.

SUMMARY

Where does all this leave the writers of floras? We would argue that a modified traditional system (binomial nomenclature, ranked hierarchies—L-code) be used in floras (allowing paraphyletic groups but eliminating all polyphyletic groups despite some nomenclatural instability), and that these floras (and this is a critical point) should also incorporate newly discovered information on phylogenetic relationships. In order to facilitate as complete an understanding of plant evolution as possible, this new information should be briefly discussed/summarized in appropriate family and generic treatments even if too preliminary, tentative, or inappropriate for nomenclatural change (e.g., that would result in the loss of meaningful paraphyletic taxa).

In summary, in the *Illustrated Flora of East Texa*, we are thus attempting to reflect some of the many contributions and insights from "phylogenetic systematics," while retaining the practical benefits of an "evolutionary taxonomy" framework. As indicated above, no system will be a totally accurate representation of the complexity of the evolutionary history of life on earth. We believe, however, that by reflecting both evolutionary relationships and the amount of

evolutionary change, while maintaining a flexible approach punctuated with practicality, that a classification and nomenclature system useful to a broad audience, including non-taxonomists, can be achieved. We agree fully with Berry (2002) who said, "there are many users of scientific names—myself included—who are interested in both floristic inventories and evolutionary relationships, and nomenclatural stability as well." Ultimately, writers of floras need to present information accurately (i.e., reflect evolution) *and* in ways that can be used—that allow effective communication and identification, promote information retrieval, and are useful comparatively (e.g., in conservation assessments, to evaluate levels of endemism, to determine levels of introduced exotics, to form the basis of biogeographical studies, to do ecological surveys). All of these uses depend on having a unit (species) that can be meaningfully compared and classification and nomenclatural systems that allows effective communication. Taxonomic botanists are thus faced with the challenge of working toward systems that make such communication and comparisons possible (Berry 2002). Writers of floras, in particular, as the translators of botanical information to a wider audience, are uniquely faced with a difficult task—to apply the evolving concepts of modern systematic botany to floristics in a way that allows modern floras to be both accurate and useful. It is hoped that this article will stimulate discussion among those involved in or interested in the writing of floras.

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THE VASCULAR FLORA OF THE LAGUNA DE ALEGRÍA, A NATIONAL MONUMENT IN THE CRATER OF TECAPA VOLCANO, EL SALVADOR

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ABSTRACT

Extreme deforestation and overuse of resources have devastated El Salvador's natural environment while continued population pressure underscores the need for the few remaining natural areas to be studied and preserved. The 150-ha Monumento Nacional Laguna de Alegría is located inside the crater of Tecapa Volcano in southeastern El Salvador and includes both primary and disturbed subtropical forest, steep and rocky crater walls, and a sulfuric lake in the basin. The flora of the Laguna de Alegría was surveyed from December 1998 to November 1999 and results of this survey were combined with reports from other collectors and published reports to compile a list of 447 specific and 2 hybrid taxa representing 106 families. The taxa are cataloged in an annotated list that includes collection number and herbarium of deposit. Exotic species are designated. *Trigonospermum annum* McVaugh & Lask. is a new report for El Salvador.

RESUMEN

La deforestación extrema y la sobreexplotación de recursos han devastado la naturaleza de El Salvador, mientras la incesante presión demográfica subraya la necesidad de estudiar y preservar las restantes áreas naturales. El Monumento Nacional Laguna de Alegría mide 150 hectáreas y está ubicado dentro del cráter del Volcán Tecapa en el sur-este de El Salvador. El parque incluye bosque subtropical primario y perturbado, paredes volcánicas rocosas y empinadas, y una laguna sulfúrica en la cuenca. Se identificó la flora de la Laguna de Alegría desde diciembre de 1998 hasta noviembre de 1999 y se combinaron los resultados del estudio con los reportes de otros colectores y reportes publicados para compilar un listado de 447 taxa específicos y 2 híbridos. Estas representan 106 familias. Los taxa fueron catalogados en un listado anotado que incluye el número de la colección y del herbario, y se designaron las especies exóticas. Es el primer reporte de *Trigonospermum annum* McVaugh & Lask. en El Salvador.

INTRODUCTION

The Republic of El Salvador, with a land area of only 21,000 km^2 and a population of more than 6 million, is the smallest and most densely crowded of the Central American countries. Extreme population pressure has devastated El Salvador's environment, causing the loss of 97% of the country's original forest (Benitez 1996 unpublished, cited from Berendsohn 1991) and forcing farmers to convert ever more forest and marginal land to crop production. Recent estimates of forest cover indicate that only 130,000 ha, or 6.1% of the national territory, is

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now covered by natural forest (DIPRAT 1997), most of which is composed of small, relictual parcels.

The government of El Salvador recognizes the urgency of protecting the few remaining forests and forest fragments in the country and has identified 125 natural areas to form the "Sistema de Areas Naturales Protegidas" (http:/www.marn.gob.sv/sia/anp.htm). These natural areas are all relatively small, but are of supreme importance as the country's last refuges for wildlife and gene pools that could provide the primary materials for reforestation and regeneration of other areas. However, there is no infrastructure to administer most of these areas; only three areas have legal protection by legislative or executive decree; and nearly all of them are still exploited for firewood, grazing lands, and for squatter's homesteads. Moreover, there is an almost complete lack of basic biological information about these areas and few in-country resources to gather this information. Apart from El Imposible National Park, none of El Salvador's protected areas has previously had a complete floral survey. While biologists from developed countries tend to disregard El Salvador in favor of studying other countries with better preserved and more extensive wild areas, the very precarious ecological situation in El Salvador should make it a high priority for study so that the natural resources still intact can be managed and preserved in the most effective manner possible.

THE LAGUNA DE ALEGRÍA

The Laguna de Alegría is a tiny but spectacular natural area in the crater of the extinct Tecapa Volcano in the department of Usulután, and is the only national monument proposed within the Salvadoran system of protected areas. Tecapa is located at 13°29'40" N latitude and 88°29'43" W longitude (Fig. 1) and rises to a height of 1599 m. It is the second largest peak in the Chinameca chain of volcanoes that dominates much of the southeastern corner of El Salvador and forms part of the Central American chain that extends from southwest Mexico, through Guatemala, El Salvador, Nicaragua, Costa Rica and Panama.

The interior of the Tecapa crater is 150 ha and is comprised of an emerald-green, sulfuric lake in the caldera surrounded by natural forest. The ecological value of this small forest is immense in this heavily deforested country and the natural beauty of the lake and sheer crater walls make for a striking setting.

There are no historical records of volcanic activity, though there are emissions of steam mixed with volcanic gases on the southwest side of the lake. The gaseous emissions, which have a high concentration of sulfur compounds, have contributed to the low pH of soils in much of the basin of the caldera and to the extreme acidity of the lake. The sulfur compounds give the lake a characteristic emerald green color and have bleached the beach and lake substrate white. It has been suggested that only algae and diatoms are able to live permanently in the extreme conditions of the water (SACDEL 1997), but exoskeletons of drag-



Fig. 1. Map of Central America showing the approximate location of the Laguna de Alegría, El Salvador.

onfly nymphs have been observed (Williams, pers. obs.) and a species of *Eleocharis* (Cyperaceae) has been reported growing in the margins of the lake (Fassett 1952).

Holdridge (1975) classifies the area in and around the summit of Tecapa Volcano as very humid subtropical forest and much of the forest is primary growth, especially those parts located on the steep inner slopes. Local residents report that some of the valuable timber species have been removed from the more accessible areas of the forest in the basin, and three areas of the forest were cleared and planted in coffee: one in a small area of the basin, now abandoned, and two others, on the northeast and northwest slopes, both still in cultivation. The inner walls of three sides of the crater are a nearly vertical 300 m tall making them inaccessible without specialized climbing equipment and only there has the forest been left completely undisturbed by humans.

The outer slopes of the volcano are not officially included in the protected area, and what parts have not been planted in coffee have been deforested for firewood. The coffee grown in plantations on the outer slopes is mixed with

shade trees, thereby offering some protection for the buffer zone. Unfortunately, the coffee plantations do not have the density of vegetation in natural forest and some recently replanted areas have come so close to the edge of the steep inner slope that severe erosion and landslides have resulted from the loss of cover (Williams, pers. obs.).

The Laguna de Alegría is currently being managed by the Asociación de Desarrollo Comunal Alberto Masferrer (ADESCAM), a local organization created in 1995 and given charge of the area for development for ecotourism and recreation by the municipal government. The area has become popular as a tourist destination due to promotion and development by ADESCAM on a national scale. However, the balance between conservation and tourism is often difficult, especially in the case of the Laguna de Alegría because the amphitheater-like setting of the interior of the crater amplifies the presence of humans in the natural area. This study was undertaken to provide ADESCAM with part of the basic biological information necessary to write a management plan for sustainable use of the area.

METHODS

The majority of the species listed in this survey are documented by herbarium vouchers we collected in the Laguna de Alegría between 9 Dec 1998 and 20 Nov 1999. Most of the vouchers were taken from the basin of the crater, e.g., the beaches of the lake, the edges of the forest along the sides of the road, and those parts of the forest accessible from the basin. Some collections were made from the top of the rim, but most of the vegetation of the cliff areas of the crater is not accounted for in this survey because we did not attempt to scale the steep slopes.

The samples were pressed and dried and sent to the herbarium at the Jardín Botánico La Laguna (LAGU) in San Salvador where we later identified them. Major references used to identify specimens include Davidse et al. (1995) and Standley and Steyermark (1960).

At LAGU we encountered specimens collected in the 1960s and 1970s in the Laguna de Alegría by the German botanist Hans Winkler. We revised those reports and added them to ours.

We also added a list of species collected by Alex Monro that are vouchered at The Natural History Museum in London (BM). Unfortunately, we were not able to visit BM and not all of Monro's collections had been identified to species at the time of this report. More information may be available when he completes his work.

In addition to reporting herbarium collections, we included reports of plants from the Laguna de Alegría in two previous publications: Fritz Hamer's book *Las Orquídeas de El Salvador* (1974) and a descriptive survey of tree species of the Laguna de Alegría made by the Salvadoran dendrologist Maria Luisa

Reyna de Aguilar (SACDEL 1997). Unfortunately, Hamer did not publish the sources of his reports and Reyna de Aguilar took only four voucher specimens during her survey, so it is not possible to verify their identifications.

Edy Montalvo (pers. com.), former curator of the herbarium of the Universidad de El Salvador (ITIC), made several collecting trips to the Laguna de Alegría in the 1970s. We had hoped to peruse ITIC's collections and add Montalvo's reports and any other specimens from the Laguna de Alegria that might be housed there, but due to a shortage of staffing, we were never able to gain permission to ITIC. It would be valuable to revise ITIC's collections and add them to this list.

After the identification phase was completed, we returned to the Laguna de Alegría and noted another 17 species that had not been collected in the previous year nor noted by other authors. We also verified an older collection of 100 woody species made in 1998 for ADESCAM.

It should be noted that we also collected non-vascular plants, i.e., mosses and lichens, during the 1999 survey. Those vouchers were deposited in LAGU as well, but since materials and expertise are not yet available to identify them, they are not included in this list.

RESULTS AND DISCUSSION

We compiled a list of 821 voucher specimens and visual reports to identify a total of 447 species and 2 hybrids of vascular plants from 319 genera and 106 families from the Laguna de Alegría (Table 1). Of the two hybrids reported in our list, one is a natural hybrid orchid, the other, the artificial hybrid that creates the many varieties of bananas and plantains. Neither of the parent species for either of these two hybrids are known from the Laguna de Alegría.

The most important families in terms of numbers of species present are Asteraceae (54 species), Fabaceae (41 species), Poaceae (34 species), and Orchidaceae (29 species and 1 hybrid). The families Asteraceae and the Poaceae both tend to be composed of pioneer and secondary vegetation specialist species and most of the species from these families found in the Laguna de Alegría were found along the roadsides, in landslide zones, and on the beaches of the laguna. Many of the species of Poaceae collected in the Laguna de Alegría are naturalized exotics. The high numbers of species in these families indicates the large amount of disturbance in many parts of the protected area.

The orchid species found in the Laguna de Alegría, on the other hand, tend to be primary forest species, and none are exotic. All of the orchids we found were in the forest or undisturbed areas of the cliffs with the exception of just two terrestrial species found in open areas. The large number of species of orchids, therefore, supports the notion that the less accessible parts of the forest have been intact and undisturbed for a long time.

The hybrid orchid, *Mormodes* × *salvadorensis* Hamer & Garay, is a natural

TABLE 1. Statistical summary by taxa of the flora of the Laguna de Alegría.

	Families	Genera	Species	Hybrids
Ferns and fern allies	13	22	34	0
Gymnosperms	3	3	4	0
Monocots	12	69	99	2
Dicots	78	225	310	0
Total	106	319	447	2

hybrid first reported by Hamer (1974) from two locations in El Salvador. One of these locations was the Laguna de Alegría, but *M.* × *salvadorensis* was not found in our 1999 survey. It is possible that it has become extirpated in the 25 intervening years. However, neither of the two parent species was found either by Hamer or by us, though they most likely exist or once existed within the bounds of the park. This fact suggests that there probably are more orchid species present which have not been recorded, a fact which is very likely considering the difficultly of encountering epiphytic orchids in the dense forest and the steep cliffs of the crater.

We found 36 exotic species in the Laguna de Alegría, making up just 8.2% of the total number of species. In comparison with a national figure of 28%, the percentage of exotic taxa in the Laguna de Alegría is very small, a fact that serves as another indicator that the area is still in a very natural state. Many of the exotics found are plants cultivated in the coffee plantations and around the margins of the lake, but nine of the species have been introduced intentionally by ADESCAM for ornamental purposes in recreational areas or for "reforestation" in areas where natural growth would have occurred. Apparently only eight species have invaded under their own power: seven grasses and "higuero" or "castor bean" (*Ricinus communis* L. Euphorbiaceae). These eight plants are all aggressive colonizers and have taken advantage of man-made disturbances such as roads and trails and other clearings to spread to new locations. One species, "frijol de palo" or "pigeon pea" (*Cajanus cajan* (L.) Millsp. Fabaceae), is of uncertain invasion status, being a plant that is widely cultivated for its edible beans, but also widely naturalized and an aggressive colonizer.

The distribution status of the majority of El Salvador's flora is poorly known, and there is no official list of threatened or endangered species for the country. At least one species collected in this survey, *Cibotium regale* Verschaff. & Lem. Dicksoniaceae, is endangered throughout its habitat (Davidse et al. 1995). The only individual of *Bixa orellana* L. Bixaceae in the Laguna de Alegría was destroyed by a landslide in 1998. However, *B. orellana* is common throughout most of El Salvador.

Despite the poor knowledge of El Salvador's flora, we found relatively few

new reports in our survey. *Trigonospermum annum* McVaugh & Lask. Asteraceae is the only verified new report for El Salvador. *Peperomia cf. liebmanii* C. DC. Piperaceae and *Tillandsia cf. kammi* Rauh Bromeliaceae, if confirmed as such, will also be new reports.

The total species count is relatively large for such a small area, especially when one considers that more extensive studies would most likely provide new reports and that the cliffs of the crater have never been surveyed. The total number of species registered for El Salvador is 4670 (Reyna de Aguilar 1995), meaning that the Laguna de Alegría, with an areal extent of less than 0.005% of the land area of the country, harbors 9.4% of the country's plant species. It is evident that the continued preservation of the tiny Laguna de Alegría is crucial to maintaining El Salvador's plant diversity.

APPENDIX

Annotated list of the vascular species of the Laguna de Alegría

Collectors/authors of reports: DW: Denise Williams and Rudys Herrera, AM: Alex Monro, FH: Fritz Hamer, JBL/Author: specimen housed at the Jardin Botanico La Laguna, MLRA: Maria Luisa Reyna de Aguilar, ADESCAM: collection of the Asociación de Desarrollo Comunal Alberto Masferrer.

* refers to introduced exotic species, ** refers to naturalized exotic species, † extinct.

Note.—At the end of each entry with multiple collections follows a list of herbaria where a duplicate of at least one of the collections was sent. This does not mean to imply that *each* herbarium has a duplicate of *every* collection listed for that entry. LAGU was the main repository for the specimens we collected and it retained one duplicate of all our collections.

DIVISION LYCOPODIOPHYTA

SELAGINELLACEAE

Selaginella sp., *DW*

DIVISION PTERIDOPHYTA

ADIANTACEAE

Adiantum princeps T. Moore, *DW136* (B, LAGU, MO)

Anogramma leptophylla (L.) Link, *DW424* (LAGU)

Cheilanthes angustifolia Kunth, *DW301* (LAGU, MO)

Cheilanthes kaulfussii Kunze, *DW348* (LAGU)

Mildella intramarginalis (Kaulf. ex Link) Trevis., *DW57, DW60* (B, EAP, LAGU, MO)

Pityrogramma calomelanes (L.) Link, *DW14, DW297* (LAGU)

ASPLENIACEAE

Asplenium auriculatum Sw., *DW53, DW413* (LAGU, MO)

Asplenium cuspidatum Lam., *DW52, DW137, DW299* (B, LAGU, MO)

Asplenium formosum Willd., *DW315, DW503* (LAGU, MO)

Asplenium sp., *DW139, DW427* (LAGU)

BLECHNACEAE

Blechnum cf. *occidentale* L., *DW55* (LAGU, MO)

Blechnum glandulosum Kaulf. ex Link, *DW54* (LAGU, MO)

DAVALIACEAE

Nephrolepis multiflora (Roxb.) F.M. Jarrett ex C.V. Morton, *DW51* (B, EAP, LAGU, MO)

DENNSTAEDTIACEAE

Pteridium caudatum (L.) Maxon, *DW521* (LAGU)

DICKSONIACEAE

Cibotium regale Verschaff. & Lem., *DW471* (B, LAGU, MEXU, MO)

DRYOPTERIDACEAE

Polystichum muricatum (L.) Fée, *DW58* (LAGU, MO)
Tectaria mexicana (Fée) C.V. Morton, *DW132* (LAGU, MO)

GLECHENIACEAE

Gleichenia bifidus (Willd.) Spreng., *DW141* (LAGU, MO)

HYMENOPHYLLACEAE

Trichomanes hymenophylloides Bosch, *DW247* (B, LAGU, MO)
Trichomanes krausii Hook. & Grev., *DW380* (LAGU)

POLYPODIACEAE

Campyloneurum angustifolium (Sw.) Fée, *DW455* (LAGU)
Pecluma alfredii (Rosenst.) M.G. Price, *DW56* (LAGU, MO)
Phlebodium pseudoaureum (Cav.) Lellinger, *DW442* (LAGU)
Pleopeltis angusta Humb. & Bonpl. ex Willd., *DW129* (B, LAGU, MO)
Polypodium furfuraceum Schltdl. & Cham., *DW300* (LAGU)
Polypodium plumula Humb. & Bonpl. ex Willd., *DW298* (LAGU)
Polypodium polypodioides (L.) Watt var. *polypodioides*, *DW50, DW243, DW436* (B, LAGU, MO)

SCHIZAEACEAE

Anemia hirsuta (L.) Sw., *DW217, DW354* (B, LAGU, MO)
Anemia oblongifolia (Cav.) Sw., *DW140* (B, LAGU, MO)
Anemia cf. *phyllitidis* (L.) Sw., *DW127* (LAGU)
Anemia speciosa C. Presl., *DW131, DW302* (LAGU, MO)

THELYPTERIDACEAE

Thelypteris oligocarpa (Humb. & Bonpl. ex Willd.) Ching, *DW59, DW237* (LAGU, MO)
Thelypteris puberula (Baker) C.V. Morton. var. *puberula*, *DW261* (LAGU)

DIVISION CONIFEROPHYTA

ARAUCACEAE

**Araucaria heterophylla* (Salisb.) Franco, *DW*

CUPRESACEAE

**Cupressus lusitanica* Mill., *DW425* (LAGU)

PINACEAE

**Pinus caribaea* Morelet, *DW*
Pinus oocarpa Schiede ex Schltdl., *ADESCAM*

DIVISION MAGNOLIOPHYTA
MONOCOTYLEDONS

AGAVACEAE

**Cordyline* sp., *DW*
Furcraea sp., *DW*
**Yucca guatemalensis* Baker, *ADESCAM*

ARACEAE

Syngonium macrophyllum Eng., *DW631* (LAGU)
**Zantedeschia aethiopica* (L.) Spreng., *DW626* (LAGU)

ARECACEAE

Chamaedora sp., *DW579* (LAGU)

BROMELIACEAE

**Ananas comosus* (L.) Merr., *DW*
Pitcairnia heterophylla (Lindl.) Beer, *DW118, DW528* (LAGU)
Pitcairnia imbricata (Brongn.) Regel, *DW337* (LAGU)
Tillandsia butzii Mez, *DW100* (B, LAGU, MO)
Tillandsia caput-medusae E. Morren, *DW530* (LAGU)
Tillandsia fasciculata Sw., *DW338* (LAGU)
Tillandsia cf. *kammi* Rauh, *DW412, DW529* (LAGU)
Tillandsia vicentina Standl., *DW254* (LAGU)

COMMELINACEAE

Commelina diffusa Burm. f., *DW151, DW190, DW327, DW331* (LAGU, MO)
Commelina erecta L., *DW328* (LAGU, MO)
Commelina leiocarpa Benth., *DW193* (LAGU)
Commelina tuberosa L., *DW382* (LAGU)
Gibasis pellucida (M. Martens & Galeotti) D.R. Hunt, *DW180* (LAGU)
Tinantia longipedunculata Standl. & Steyerm., *DW333* (LAGU)
Tradescantia zanonia (L.) Sw., *DW155, DW519* (LAGU)
Tripogandra montana Handlos, *DW322* (LAGU, MO)

CYPERACEAE

Bulbostylis tenuifolia (Rudge) J.F. Macbr., *DW206, DW390* (B, LAGU, MO)

Cyperus aggregatus (Willd.) Endl., *DW221, DW335* (B, LAGU, MO)
Cyperus amabilis Vahl, *DW222* (LAGU)
Cyperus hermaphroditus (Jacq.) Standl., *DW128, DW134, DW149* (LAGU, MO)
Cyperus laxus Lam., *DW195* (LAGU, MO)
Cyperus tenerrimus J. Presl. & C. Presl., *DW496* (LAGU)
Eleocharis filiculmis Kunth, *DW274, AM3025* (BM, LAGU, MO)
Rhynchospora contracta (Nees) J. Raynal, *DW318* (LAGU)
Torulinium odoratum (L.) S.S. Hooper, *DW334* (B, LAGU, MO)

DIOSCOREACEAE

Dioscorea mexicana Scheidw., *DW381, DW520* (B, LAGU, MO)

HYPOXIDACEAE

Hypoxis decumbens L., *DW377* (LAGU)

IRIDACEAE

Sisyrinchium tinctorium Kunth, *DW623* (LAGU)

LILIACEAE

Bomeria sp., *DW619* (LAGU)
Echeandea skinnerii (Baker) Cruden, *DW290* (B, LAGU, MO)

MUSACEAE

**Musa* x *paradisiaca* L. (pro. sp.), *DW*

ORCHIDACEAE

Bletia purpurea (Lam.) A. DC., *DW244, DW500, DW516* (LAGU, MO)
Cattleya aurantiaca (Batem.) P.N. Don, *DW150* (LAGU)
Cranichis apiculata Lindl., *FH*
Cycnoches egertonianum Batem., *JBL142* (LAGU)
Deiregyne hemichrea (Lindl.) Schltr., *DW43, DW527, FH* (LAGU, MO)
Encyclia baculus (Rchb. f.) Dressler & G.E. Pollard, *DW487* (LAGU)
Encyclia ochracea (Lindl.) Dressler, *DW536* (LAGU)
Epidendrum ciliare L., *DW387* (LAGU, MO)
Govenia ciliilabia Ames & Schweinf., *JBL768/Winkler* (LAGU)
Govenia liliacea (La Llave & Lex.) Lindl., *JBL386/Hamer, FH* (LAGU)
Govenia mutica Rchb. f., *DW391, FH* (LAGU)
Govenia utriculata (Sw.) Lindl., *FH*
Habenaria alata Hook., *DW347* (LAGU)
Habenaria floribunda Lindl., *JBL793/Winkler, FH* (LAGU)
Hexadesmia crurigera Batem. ex Lindl., *DW248, DW404, DW501* (B, LAGU, MO)
Hexadesmia micrantha Lindl., *DW414* (B, LAGU, MO)
Isochilus amparoanus Schltr., *DW148, DW346, DW510* (LAGU)
Laelia rubescens Lindl., *DW537* (LAGU)
Lycaste sulfurea Rchb.f., *DW518, FH, JBL394, JBL842* (B, K, LAGU, MO, SEL)
Maxillaria variabilis Batem. ex Lindl., *DW246, DW403* (B, LAGU, MO)
Mormodes x salvadorensis Hamer & Garay, *FH*
Pleurothallis quadrifida (Lex.) Lindl., *DW267, DW385, FH* (LAGU, MO)
Ponthieva cf. *triloba* Schltr., *DW340* (LAGU)
Sarcoglottis rosulata (Lindl.) P.N. Don, *FH*
Sobralia macrantha Lindl., *DW384* (LAGU)
Spiranthes sp. I, *DW252* (LAGU)
Spiranthes sp. II, *DW379* (LAGU, MO)
Stelis vestita Ames, *DW535* (LAGU)
Trichopilia maculata Rchb. f., *FH*

POACEAE

Aegopogon cenchroides Humb. & Bonpl. ex Willd., *DW356* (B, LAGU, MO)
Andropogon angustatus (J. Presl) Steud., *DW292* (LAGU)
Andropogon leucostachyus Kunth, *DW126* (B, LAGU, MO)
Aristida capillacea Lam., *DW173* (B, K, LAGU, MO)
***Arthraxon hispidus* (Thunb.) Makino var. *hispidus, DW5, DW178* (B, LAGU, MO)
Axonopus capillaris (Lam.) Chase, *DW314, DW523* (LAGU)
Chloris radiata (L.) Sw., *DW17* (LAGU, MO)
***Cynodon dactylon* (L.) Pers., *DW423* (LAGU)
Digitaria ciliaris (Retz.) Koeler, *DW281, DW287, DW288, DW289* (B, LAGU, MO)
***Eleusine indica* (L.) Gaertn., *DW71, DW179, DW309* (B, LAGU, MO)
Eragrostis hypnoides (Lam.) Britton et al., *DW512* (B, EAP, K, LAGU, MO)
Eragrostis mexicana Davidse subsp. *mexicana, DW220, DW294* (B, LAGU, MO)
***Hyparrhenia rufa* (Nees) Stapf, *DW70, DW108* (LAGU, MO)
Lasiacis procerrima (Hack.) Hitchc., *DW321* (LAGU)

****Melinis minutifolia** P. Beauv., *DW76, DW123, DW212* (LAGU, MO)
Muhlenbergia tenella (Kunth) Trin., *DW341, DW357, DW361* (B, LAGU, MO)
Oplismenus burmanii (Vasey) McVaugh var. *nudicaulis, DW133, DW352* (B, LAGU, MO)
Oplismenus hirtellus (L.) Beauv., *DW526* (LAGU)
Panicum arundinariae Trin. ex E. Fourn., *DW176* (LAGU)
****Panicum maximum** Jacq., *DW293* (LAGU)
Panicum trichoides Sw., *DW199* (LAGU)
Panicum sp., *DW39* (K, LAGU, MO)
Paspalum candidum (Humb. & Bonpl. ex Flüggé) Kunth, *DW264, DW364* (LAGU, MO)
Paspalum clavuliferum C. Wright, *DW312* (LAGU)
Paspalum convexum Humb. & Bonpl. ex Flüggé, *DW185, DW219, DW313* (LAGU)
Paspalum costaricense Mez, *DW282, DW283* (LAGU)
Paspalum notatum Flüggé, *DW286, DW310* (LAGU, MO)
Paspalum paniculatum L., *DW284* (B, LAGU, MO)
Pennisetum complanatum (Nees) Hemsl., *DW514* (LAGU, MO)
****Rhynchelytrum repens** (Willd.) C.E. Hubb., *DW61, DW311, DW479* (LAGU, MO)
Setaria parviflora (Poir.) Kerguelen, *DW291, DW360* (B, LAGU, MO)
Sporobolus indicus (L.) R. Br., *DW4, DW285* (B, K, LAGU, MO)
cf. *Urochloa* sp., *DW462* (LAGU, MO)
undetermined sp., *DW363, DW504* (LAGU, MO)

DIVISION MAGNOLIOPHYTA
DICOTYLEDONS

ACANTHACEAE
Blechum browneii Juss., *DW19* (LAGU)
Elytraria imbricata (Vahl) Pers., *DW65, DW120* (B, LAGU, MO, US)
Henrya insularis Nees, *DW153, DW459* (B, LAGU, MO)
Tetramerium nervosum Nees, *DW146* (B, LAGU, MO)

ACTINIDACEAE
Saurauia kegeliana Schltdl., *DW565* (LAGU)

AMARANTHACEAE
Achyranthes indica (L.) Mill., *DW11, DW109* (B, LAGU, MO)
Amaranthus spinosus L., *DW230* (LAGU)
Chamissoa altissima (Jacq.) Kunth, *DW256* (B, F, LAGU, MO)
Iresine calea (Ibañez) Standl., *DW26* (B, F, LAGU, MO)
Iresine diffusa Humb. & Bonpl. ex Willd., *DW20, DW42, DW46, DW69, DW355* (B, F, LAGU, MO)
Pleuropetalum sprucei (Hook. f.) Standl., *DW471* (LAGJ)

ANACARDIACEAE
***Mangifera indica** L., *DW513* (LAGU)
Rhus terebinthifolia Schltdl. & Cham., *DW453* (LAGU)
Spondias purpurea L., *ADESCAM*

ANNONACEAE
Annona cherimola Mill., *DW434, AM3019* (BM, LAGU)
Annona diversifolia Saff., *DW629* (LAGU)
Annona holosericea Saff., *MLRA*

APIACEAE
Spananthe paniculata Jacq., *DW345* (LAGU, MO)

APOCYNACEAE
Alstonia longifolia (A. DC.) Pichon, *ADESCAM*
***Thevetia peruviana** (Pers.) K. Schum., *DW551* (LAGU)

ARALIACEAE
Oreopanax xalapensis (Kunth) Decne. & Planch., *DW87* (LAGU)

ARISTOLOCHIACEAE
Aristolochia sp., *DW*

ASCLEPIADACEAE
Gonolobus lasiostemma (Hemsl.) Woodson, *DW428* (LAGU, MO)

ASTERACEAE
Acmella alba (L'Her.) R.K. Jansen, *DW117, DW231* (B, K, LAGU, MO)
Ageratum conyzoides L., *DW125* (B, LAGU, MO)
Baccharis trinervis Pers., *DW78* (LAGU, MO)
Baccharis monoica G.L. Nesom, *DW116* (LAGU)
Bidens pilosa L., *DW200, DW303* (LAGU)
Bidens squarrosa Kunth, *DW25, DW27, DW228* (K, LAGU, MO)
Calyptocarpus wenlandii Sch. Bip., *DW415* (LAGU)
Chaptalia nutans (L.) Pol., *DW386* (LAGU, MO)
Chromolaena odorata (L.) R.M. King & H. Rob., *DW86* (LAGU)

Conyza bonariensis (L.) Cronquist, *DW410, DW431* (LAGU)
Coreopsis mutica D.J. Crawford var. *microcephala, DW81, DW441* (LAGU)
Critonia daleoides DC., *DW112, DW250* (LAGU, MO)
Critonia morifolia (Mill.) R.M. King & H. Rob., *DW277, DW463* (LAGU, MO)
**Dahlia imperialis* Roezl ex Ortgies, *DW74* (B, LAGU, MO)
Eclipta prostrata (L.) L., *DW326* (LAGU, MO)
Elephantopus mollis Kunth, *DW68, DW207* (B, LAGU, MO)
Elephantopus spicatus B. Juss. ex Aubl., *DW18* (B, K, LAGU, MO)
Erechtites valerianaefolius (Link ex Spreng.) DC., *DW373* (LAGU, MO)
Erigeron karvinskianus DC., *DW422, DW488* (LAGU)
Fleischmanniopsis leucocephala (Benth.) R.M. King & H. Rob., *DW226* (LAGU)
Galinsoga caracasana (DC.) Sch. Bip., *DW103* (LAGU, MO)
Galinsoga urticifolia (Kunth) Benth., *DW419, DW421* (B, LAGU, MO)
Jaegeria hirta (Lag.) Less., *DW191* (LAGU)
Koanophyllon cf. *standleyi* (Robinson) R.M. King & H. Rob., *DW165* (B, LAGU, MO)
Lasianthaea fruticosa (L.) K.M. Becker, *DW209* (LAGU)
Melampodium divaricatum (Rich. ex Pers.) DC., *DW306, DW308, DW401* (B, LAGU, MO)
Melampodium paniculatum Gardner, *DW115, DW305, DW307, DW323* (B, K, LAGU, MO)
Melanthera nivea (L.) Small, *DW105* (B, K, LAGU, MO)
Onoseris onoseroides (Kunth) B.L. Rob., *DW271* (LAGU)
Otopappus glabratus (J.M. Coult.) S.F. Blake, *DW164, DW402* (LAGU, MO)
Perymenium grande Hemsl. var. *grande*, *DW88* (LAGU, MO)
Peteravenia schultzii R.M. King & H. Rob., *DW6, DW113, DW395* (B, K, LAGU, MO)
Roldana petasioides (Greenm.) H. Rob., *DW85* (B, K, LAGU, MO)
Sinclaria discolor Hook. & Arn., *DW12* (LAGU)
Sinclaria sublobatum H. Rob., *DW15* (LAGU, MO)
Sinclaria sp., *DW510* (LAGU)
Sonchus oleraceus L., *DW229, DW295* (LAGU, MO)
Stevia ovata Willd., *DW84, DW389* (B, K, LAGU, MO)
Stevia tephrophylla S.F. Blake, *DW351* (LAGU)
Synedrella nodiflora (L.) Gaertn., *DW90* (B, K, LAGU, MO)
Tagetes filifolia Lag., *DW397* (LAGU)
Tagetes tenuifolia Cav., *DW21, DW83* (B, LAGU, MO)
Telanthophora arborescens (Steetz) H. Rob. & Brettell, *DW238* (B, LAGU, MO)
Tithonia rotundifolia (Mill.) S.F. Blake, *DW187* (LAGU, MO)
Tridax procumbens L., *DW216, DW430* (B, LAGU, MO)
Trigonospermum annuum McVaugh & Lask., *DW203* (LAGU, MO)
Verbesina cf. *punctata* B.L. Rob. & Greenm., *DW82* (LAGU)
Verbesina sp., *DW367* (B, K, LAGU, MEXU, MO)
Vernonia cf. *deppeana* Less., *DW263* (B, LAGU, MO)
Vernonia leiocarpa DC., *DW9* (B, K, LAGU, MO)
Vernonia patens Kunth, *DW114* (B, K, LAGU, MO)
cf. *Vernonia* sp., *DW517* (LAGU)
Wedelia parviceps S.F. Blake, *DW23, DW157, DW249, DW420* (LAGU)
***Zinnia elegans* Jacq., *DW251, DW399* (B, K, LAGU, MO)

BEGONIACEAE

Begonia plebeja Liebm., *DW79* (LAGU)

BIGNONIACEAE

**Jacaranda mimosifolia* D. Don, *DW550* (LAGU)
Macfadyena unguis-cati (L.) A.H. Gentry, *DW435* (LAGU)
Tabebuia cf. *chrysantha* (Jacq.) G. Nicholson, *ADESCAM*
Tabebuia rosea (Bertol.) A. DC., *DW260* (B, EAP, LAGU, MEXU, MO)
Tecoma stans (L.) Juss. ex Kunth, *DW28, DW106* (LAGU, MO)

BIXACEAE

†*Bixa orellana* L., *ADESCAM*

BOMBACACEAE

Ceiba aesculifolia (Kunth) Britt. & Baker f., *MLRA*
Ceiba pentandra (L.) Gaertn., *DW576* (LAGU)

BORAGINACEAE

Cordia alliodora (Ruiz & Pav.) Oken, *ADESCAM*
Cordia bullata (L.) Roem. & Schult., *DW296, DW400* (B, LAGU, MO)

Cordia inermis (Mill.) I.M. Johnst., *DW426* (LAGU)
Heliotropium rufipilum (Benth.) I.M. Johnst., *DW259* (B, LAGU, MO)
Heliotropium sp., *DW124* (B, EAP, LAGU, MO)

BRASSICACEAE
Lepidium virginicum L., *DW268, DW417* (LAGU, MO)

BURSERACEAE
Bursera simaruba (L.) Sarg., *DW445, AM3023* (BM, LAGU)

CAMPANULACEAE
Diastatea micrantha (Kunth) McVaugh, *DW8, DW272, DW330* (B, LAGU, MO)
Lobelia laxiflora Kunth, *DW67, DW152* (LAGU)

CARICACEAE
Carica cauliflora Jacq., *DW121* (LAGU)

CARYOPHYLLACEAE
Arenaria lanuginosa (Michx.) Rohrb., *DW407* (LAGU, MO)
Drymaria cordata (L.) Willd. ex Schult., *DW213, DW383* (B, LAGU, MO)
Stellaria ovata Willd. ex Schltdl., *DW408* (LAGU, MO)

CASUARINACEAE
**Casuarina equisetifolia* L., *DW621* (LAGU)

CECROPIACEAE
Cecropia peltata L., *DW577* (LAGU)

CLETHRACEAE
Clethra lanata M. Martens & Galeotti, *MLRA*
Clethra mexicana DC., *DW143, DW438* (B, EAP, LAGU, MO)

CLUSIACEAE
Calophyllum brasiliense (Standl.) Standl. var. *rekoi, DW524* (LAGU, MO)
cf. *Garcinia* sp., *DW452* (LAGU)

COCHLOSPERMACEAE
Cochlospermum vitifolium (Willd.) Spreng., *ADESCAM*

CONVOLVULACEAE
Ipomoea cholulensis Kunth, *DW154, DW158, DW241* (LAGU, MO)
Ipomoea cf. *mairetii* Choisy, *DW208* (LAGU)
Ipomoea santae-rosae Standl. & Steyerm., *DW145* (LAGU)
Ipomoea squamosa Choisy, *DW177, DW350* (B, LAGU, MO)
Ipomoea cf. *trifida* (Kunth) G. Don, *DW47* (LAGU, MO)
Ipomoea umbraticola House, *DW44, DW227, DW278* (B, LAGU, MO)

CUCURBITACEAE
Cayaponia sp., *DW620* (LAGU)
Microsechium sp., *DW188* (LAGU, MO)
Rytidostylis ciliata (Cogn) Kuntze, *DW62, DW98* (LAGU)
Sechium edule (Jacq.) Sw., *DW*
Sycios sertuliferus Cogn., *DW142* (LAGU, MO)

ERICACEAE
Gaultheria erecta Vent., *DW437* (LAGU, MO)

EUPHORBIACEAE
Acalypha macrostachya Jacq., *DW255* (B, LAGU, MO)
Chamaesyce hirta (L.) Millsp., *DW324, DW511* (LAGU)
Croton xalapensis Kunth, *DW89* (B, F, LAGU, MO)
Euphorbia graminea Jacq., *DW172, DW498* (LAGU)
Euphorbia heterophylla L., *DW66* (B, K, LAGU, MO)
**Euphorbia pulcherrima* Willd. ex Klotzsch, *ADESCAM*
**Ricinus communis* L., *DW122* (LAGU)

FABACEAE
Acacia hindsii Benth., *DW443* (LAGU)
**Caesalpinia pulcherrima* (L.) Sw., *DW80* (LAGU, MO)
**Cajanus cajan* (L.) Millsp., *DW175* (LAGU)
Calliandra sp., *DW627* (LAGU)
Canavalia sp., *DW38* (K, LAGU, MO)
**Cassia siamea* Lam., *DW575* (LAGU)
Centrosema virginianum (L.) Benth, *DW210* (LAGU, MO)
Chamaecrista nictitans (L.) Moench, *DW239, DW359* (LAGU)
Chamaecrista zygophylloides (Britton & Rose) H.S. Irwin & Barneby var. *deamii, DW444* (LAGU)
Clitoria mexicana Link, *DW204* (LAGU)
Cologania cf. *rufescens* Rose, *DW181* (LAGU)
Coursetia caribaea (Jacq.) Lavin, *DW130* (LAGU, MO)
Crotalaria mollicula Kunth, *DW138* (B, LAGU, MO)
Dalea cliffortiana Willd., *DW349* (B, LAGU, MO)
Dalea sp., *DW240* (LAGU)
Desmodium barbatum (L.) Benth., *DW342* (LAGU)
Desmodium cajanifolium (Kunth) DC., *DW447* (LAGU)

Desmodium incanum DC., *DW406, DW414* (LAGU)
Desmodium procumbens (Schindl.) B.G. Schub. var. *longipes, DW194* (B, K, LAGU, MO)
Diphysa robinioides Benth., *DW520* (LAGU, MO)
Erythrina berteroana Urb., *ADESCAM*
Hymenaea courbaril L., *ADESCAM*
Inga paterno Harms, *DW*
Inga pavoniana G. Don, *DW571* (LAGU)
Inga punctata Willd., *DW523* (LAGU)
Lonchocarpus rugosus (Lundell) M. Sousa subsp. *apricus, DW448, DW454* (LAGU, MO)
Lysiloma cf. *acapulcense* (Kunth) Benth., *DW439* (B, LAGU, MEXU, MO)
Macroptilium atropurpureum (Moc. & Sessé ex DC.) Urb., *DW273* (LAGU)
Mimosa albida Humb. & Bonpl. ex Willd., *DW170* (B, K, LAGU, MO)
Mimosa pudica L., *DW378* (LAGU)
Phaseolus leptostachyus Benth., *DW169, DW214* (LAGU, MO)
Phaseolus lunatus L., *DW3* (B, LAGU)
Piscidia grandifolia (Donn. Sm.) I.M. Johnst., *DW469* (LAGU)
Poiretia punctata (Willd.) Desv., *DW174* (LAGU, MO)
Senna hirsuta H.S. Irwin & Barneby var. *hirta, DW372* (B, LAGU, MO)
Spathodia campanulata Beauv., *DW*
Stylosanthes guianensis (Aubl.) Sw., *DW41, DW96* (B, K, LAGU, MO)
Teramnus uncinatus (L.) Sw., *DW182* (LAGU)
Vigna sp., *DW183* (LAGU)
Zapoteca tetragona (Willd.) H.M. Hern., *DW135* (LAGU, MO)
Zornia diphylla (L.) Pers., *DW171* (LAGU)

FAGACEAE
Quercus sapotifolia Liebm., *DW144,, MLRA1506* (B, K, LAGU, MO)
Quercus sp., *DW97, DW269* (LAGU)

FLACOURTIACEAE
Casearia sylvestris Sw., *DW467, DW451, MLRA1504* (B, LAGU, MEXU, MO,)
Prockia crucis P. Br. ex L., *DW375, AM3012* (B, BM, LAGU, MEXU, MO)
Xylosma flexuosa (Kunth) Hemsl., *DW339* (LAGU)

GESNERIACEAE
Achimenes erecta (Lam.) H.P. Fuchs, *DW394, DW492* (LAGU, MO)
Achimenes longiflora DC., *DW329* (B, LAGU, MO)
Achimenes misera Lindl., *DW344* (LAGU, MO)
Achimenes pedunculata Benth., *DW63, DW365, DW374* (B, LAGU, MO)
Phinaea repens (Donn. Sm.) Soler., *DW316* (B, LAGU, MO)

HERNANDACEAE
Gyrocarpus americanus Jacq., *DW569* (LAGU)

HYDROPHYLLACEAE
Wigandia urens (Ruiz & Pav.) Kunth, *DW223* (LAGU)

JUGLANDACEAE
Juglans olanchana Standl. & L.O. Williams, *DW*

LAMIACEAE
Hyptis pectinata (L.) Poit., *DW45* (B, LAGU, MO)
Hyptis suaveolens (L.) Poit., *DW94* (LAGU)
Hyptis urticoides Kunth, *DW101, DW205* (B, LAGU, MO)
Marsypianthes chamaedrys (Vahl) Kuntze, *DW370* (B, LAGU, MO)
Salvia occidentalis Sw., *DW2, DW111, DW353* (B, K, LAGU, MO)
Salvia polystachya Ortega, *DW110* (LAGU, MO)
Salvia purpurea Cav., *DW270* (B, LAGU, MO)
**Salvia splendens* Sellow ex Roem. & Schult., *DW40* (B, K, LAGU, MO)

LAURACEAE
Nectandra sinuata Mez, *DW538* (LAGU)
Persea americana Mill., *ADESCAM*

LOASACEAE
Klaprothia fasciculata (C. Presl.) Poston, *DW332, DW524* (B, LAGU, MO)
Metzelia sp., *DW358, DW376* (LAGU)

LOGANIACEAE
Buddleja americana L., *DW266* (LAGU)

LORANTHACEAE
Oryctanthus cordifolius (C. Presl.) Urban, *DW522* (LAGU)

MALPIGHIACEAE
Byrsonima crassifolia (L.) Kunth, *ADESCAM*
Gaudichaudia albida Cham. & Schltdl., *DW93, DW168* (B, LAGU, MO)
Tetrapteris schiedeana Cham. & Schltdl., *DW37, DW343, DW494, DW499* (LAGU)
Stigmaphyllon ellipticum (Kunth) A. Juss., *DW33* (LAGU, MO)

MALVACEAE

**Hibiscus rosa-sinensis* L., *DW236* (B, LAGU, MO)
Malvaviscus arboreus Cav., *DW75* (B, EAP, LAGU, MO, US)
Sida acuta Burm. f., *DW92* (B, LAGU, MO)
Sida glabra Mill., *DW34* (LAGU, MO)
Sida urens L., *DW72* (LAGU, MO)

MELASTOMATACEAE

Conostegia xalapensis (Bonpl.) D. Don ex DC., *DW258, DW446, AM3001* (B, BM, LAGU, MO)
Heterocentron hondurense Gleason, *DW95* (LAGU, MO)
Heterocentron glandulosum var. *longicalyx* Whiffin, *DW167* (LAGU)
Miconia argentea (Sw.) DC., *MLRA*
Miconia guatemalensis Cogn., *DW369, DW468, AM3022* (B, BM, CAS, LAGU, MEXU, MO)
Miconia lauriformis Naudin, *DW196* (LAGU)
Monochaetum floribundum (Schltdl.) Naudin, *DW35* (B, CAS, LAGU, MO)
Pterolepis pumila (Bonpl.) Cogn., *DW102, DW325* (B, LAGU, MO)
Schwackaea cupheoides (Benth.) Cogn., *DW32* (LAGU)
Tibouchina longifolia (Vahl) Baill., *DW91, DW99* (LAGU)

MELIACEAE

Cedrela odorata L., *DW392, DW474* (LAGU)
Cedrela tonduzii C. DC., *MLRA*
**Melia azedarach* L., *DW*
Trichilia havanensis Jacq., *DW64, DW371, AM3020* (BM, LAGU)
Trichilia hirta L., *DW257, AM3009* (BM, LAGU)
Trichilia tomentosa Kunth, *MLRA*

MENISPERMACEAE

Cissampelos pareira L., *DW509* (LAGU, MO)

MORACEAE

Ficus goldmanii Standl., *DW211* (LAGU)
Ficus obtusifolia Kunth, *DW215, DW539* (LAGU)
Ficus ovalis (Liebm.) Miq., *DW163, DW166, DW405, DW409* (B, LAGU, MO)
Ficus pertusa L. f., *DW186* (B, F, LAGU, MO)

MYRICACEAE

Myrica cerifera L., *DW31, DW440* (B, LAGU, MO)

MYRSINACEAE

Ardisia compressa Kunth, *DW119, DW162* (LAGU, MO)
Rapanea myricoides (Schltdl.) Lundell, *DW411* (LAGU)

MYRTACEAE

Eugenia cf. *acapulcensis* Steud., *AM3003* (BM, LAGU)
Psidium guajava L., *MLRA*
Psidium guineense Sw., *DW16, DW77, DW533* (LAGU, MO)
Psidium oerstedianum O. Berg, *MLRA*

NYCTAGINACEAE

**Bougainvillea glabra* Choisy, *DW235* (LAGU)
Mirabilis jalapa L., *DW161, DW253* (LAGU)
cf. *Mirabilis* sp., *DW388* (LAGU)
Pisonia aculeata L., *DW265, DW336* (LAGU)

OXALIDACEAE

Oxalis corniculata L., *DW505* (LAGU)
Oxalis debilis (DC.) Lourteig var. *corymbosa*, *DW622* (LAGU)
Oxalis frutescens L., *DW1, DW159, DW497, DW517* (B, F, LAGU, MO)

PAPAVERACEAE

Bocconia frutescens L., *DW234* (LAGU)

PASSIFLORACEAE

Passiflora ornithoura Mast., *DW49* (LAGU)

PHYTOLACCACEAE

Phytolacca icosandra L., *DW160, DW418* (LAGU, MO)
Rivina humilis L., *DW13, DW107* (B, LAGU, MO)

PIPERACEAE

Peperomia arboricola C. DC., *DW280* (LAGU, MO)
Peperomia granulosa Trel., *DW317* (LAGU, MO)
Peperomia deppeana Schltdl. & Cham., *DW279* (LAGU, MO)
Peperomia lanceolato-peltata (C. DC.), *DW531* (LAGU, MO)
Peperomia cf. *liebmannii* C. DC., *DW515* (F, LAGU, MO)
Peperomia sp., *DW184* (LAGU)
Piper amalago L., *DW456, DW458, DW462, DW466* (LAGU, MO)
Piper hispidum Sw., *DW473, DW464* (LAGU, MO)
Piper jacquemontianum Kunth, *DW304, DW485* (LAGU)
Piper marginatum Jacq., *DW475, DW486* (LAGU)
Piper umbellatum L., *DW461, DW474* (LAGU)

POLEMONIACEAE

Loeselia glandulosa (Cav.) G. Don, *DW7, DW73, DW507* (B, LAGU, MO)

POLYGALACEAE

Polygala hondurana Chodat, *DW48, DW320* (LAGU)

Polygala longicaulis Kunth, *DW393, DW525* (LAGU, MO)

Polygala paniculata L., *DW225, DW398, DW493* (LAGU)

Polygala sp., *DW189* (LAGU)

PORTULACACEAE

Talinum paniculatum (Jacq.) Gaertn., *DW618* (LAGU)

PROTEACEAE

Roupala glaberrima Pittier, *DW470* (LAGU)

RHAMNACEAE

Colubrina reclinata (L'Her.) Brongn., *DW570* (LAGU)

ROSACEAE

**Eriobotrya japonica* (Thunb.) Lindl., *DW*

Prunus brachybotrya Zucc., *MLRA1505, AM3013* (BM, LAGU)

Rubus irasuensis Liebm., *DW449, DW476* (LAGU, MO)

**Rubus niveus* Thunb., *DW481* (B, LAGU, MO)

RUBIACEAE

Borreria cf. *latifolia* (Aubl.) K. Schum., *DW362* (LAGU)

Borreria ocymoides (Burm.f.) DC., *DW201, DW218, DW232* (B, F, LAGU, MO)

Bouvardia leiantha Benth., *DW276, DW480, DW484* (B, LAGU, MO)

**Coffea arabica* L., *DW460* (LAGU)

**Coffea liberica* W. Bull ex Hiern, *DW*

Crusea longiflora (Willd. ex Roem. & Schult.) W.R. Anderson, *DW495* (LAGU)

Hamelia patens Jacq., *DW233, DW464* (B, LAGU, MO)

Hoffmannia angustifolia Standl., *AM3002* (BM, LAGU)

Manettia reclinata L., *DW192* (LAGU)

Mitracarpus villosus (Sw.) Cham. & Schltdl., *DW22, DW533, DW534* (LAGU, MO)

Psychotria pubescens Sw., *DW366* (LAGU, MEXU, MO)

Richardia scabra L., *DW30* (LAGU, MO)

RUTACEAE

Casimiroa edulis La Llave & Lex., *DW197* (B, LAGU, MO)

**Citrus limetta* Risso, *ADESCAM*

**Citrus sinensis* (L.) Osbeck, *DW*

Zanthoxyllum cf. *culantrillo* Kunth, *ADESCAM*

SAPINDACEAE

Sapindus saponaria L., *DW457* (LAGU)

SAPOTACEAE

Sideroxylon persimile (Hemsl.) T.D. Penn., *DW242, AM3018* (BM, LAGU, MO)

SCROPHULARIACEAE

Castilleja arvensis Schltdl. & Cham., *DW104* (B, BKL, F, LAGU, MO)

Russelia sarmentosa Jacq., *DW275, DW506* (LAGU)

SOLANACEAE

Brachistus stramoniifolius (Kunth) Miers, *DW528* (B, LAGU, MO)

Cestrum lanatum M. Martens & Galeotti, *DW432* (LAGU)

Physalis pubescens L., *DW529, DW530* (B, LAGU, MO)

Solanum lanceifolium Jacq., *DW513, DW521* (LAGU, MO)

Solanum nigrum var. *americanum* (Mill.) O.E. Schulz, *DW147* (LAGU)

Solanum torvum Sw., *DW473* (LAGU)

STERCULIACEAE

Waltheria glomerosa C. Presl., *DW198* (LAGU)

Waltheria indica L., *DW36, DW198* (LAGU, MO)

STYRACACEAE

Styrax argenteus C. Presl., *DW411* (B, LAGU, MO)

TILIACEAE

Heliocarpus mexicanus (Turcz.) Sprague, *DW479* (B, EAP, LAGU, MEXU, MO)

Triumfetta speciosa Seem., *DW202* (LAGU)

Triumfetta bogotensis DC., *DW478* (LAGU)

ULMACEAE

Trema micrantha (L.) Blume, *ADESCAM*

Ulmus mexicana (Leibm.) Planch, *DW*

URTICACEAE

Boehmeria caudata Sw., *DW24, DW482, AM3011* (B, BM, LAGU, MO)

Myriocarpa longipes Liebm., *DW483* (LAGU, MO)

Pilea hyalina Fenzl., *DW319* (LAGU)

Urera cf. *baccifera* (L.) Gaudich., *AM3016* (BM, LAGU)
Urera caracasana (Jacq.) Grisebach., *DW396, DW489, DW490* (LAGU)

VALERIANACEAE
Valeriana scandens (Gardn.) K.A.E. Muell. var. *candolleana, DW224, DW245* (LAGU, MO)

VERBENACEAE
Cornutia pyramidata L., *DW368, DW416* (LAGU, MO)
Citharexylum donnell smithii Greenm., *DW10, DW29, DW429* (B, EAP, LAGU, MO)
Lantana camara L., *DW156* (B, EAP, LAGU, MO)
Lippia myriocephala Schltdl. & Cham., *DW472* (B, EAP, LAGU, MEXU, MO)

VITACEAE
Cissus erosa Rich., *DW624* (LAGU)

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THE FLORA OF OKTIBBEHA COUNTY, MISSISSIPPI

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ABSTRACT

We surveyed the flora of Oktibbeha County, Mississippi, U.S.A., from February 1994 to 1996. Occupying 118 square kilometers in east-central Mississippi, Oktibbeha County lies among 3 physiographic regions that include, from west to east, Interior Flatwoods, Pontotoc Ridge, and Black Prairie. Accordingly, the county harbors a diverse flora. Based on field work, as well as an extensive review of published literature and herbarium records at IBE and MISSA, we recorded a total of 1,148 taxa (1,125 species, 7 hybrids, 16 infraspecific taxa) belonging to 514 genera in 160 families; over 85% of all taxa documented were native. Compared to 3 other counties in east-central Mississippi, Oktibbeha County has the second largest recorded flora. The number of state-listed (endangered, threatened, or of special concern) taxa (67) documented in this survey far exceeds that reported from any other county in the region. Three introduced species, *Ilex cornuta* Lindl. & Paxton, *Mahonia bealei* (Fortune) Carrière, and *Nandina domestica* Thunb., are reported in a naturalized state for the first time from Mississippi. We also describe 16 different plant communities belonging to 5 broad habitat categories: bottomland forests, upland forests and prairies, aquatic habitats, seepage areas, and human-influenced habitats. A detailed description of the vegetation associated with each of these communities is provided.

RESUMEN

Hemos investigado la flora del condado de Oktibbeha, Mississippi, U.S.A., desde febrero de 1994 a 1996. Con 118 kilómetros cuadrados en el centro-este de Mississippi, el condado de Oktibbeha está entre 3 regiones fisiográficas que son, de oeste a este, Interior Flatwoods, Pontotoc Ridge, y Black Prairie. Consecuentemente, el condado alberga una flora diversa. Basados en el trabajo de campo, así como en una extensa revision de la bibliografía publicada y pliegos de herbario depositado en IBE y MISSA, hemos recopilado un total de 1,148 taxa (1,125 especies, 7 híbridos, 16 taxa infraespecíficos) pertenecientes a 514 géneros de 160 familias; más del 85% de los taxa documentados fueron autóctonos. Comparado con otros 3 condados del centro-este de Mississippi, el condado de Oktibbeha tiene la segunda flora más numerosa. El número de taxa (67) listados para el estado (en peligro, amenazada, o de atención especial) documentados en este trabajo excede con mucho a los de cualquier otro condado de la región. Tres especies introducidas, *Ilex cornuta* Lindl. & Paxton, *Mahonia bealei* (Fortune) Carrière, y *Nandina domestica* Thunb., se citan en estado naturalizado por primera vez en Mississippi. También se describen 16 comunidades vegetales diferentes pertenecientes a 5 categorías de hábitat: bosques de tierras bajas, bosques de meseta y praderas, hábitats acuáticos, áreas de filtración, y hábitats influenciados por el hombre. Se aporta una descripción detallada de la vegetación asociada a cada una de estas comunidades.

ZUSAMMENFASSUNG

Wir untersuchten die Flora des Verwaltungsbezirks Oktibbeha im Bundesstaat Mississippi, Vereinigte Staaten von Amerika, im Zeitraum Februar 1994 bis 1996. Der Verwaltungsbezirk umfaßt 118

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Quadratkilometer im Mittelosten Mississippis und gehört, von West nach Ost, zu 3 physiographischen Regionen (Interior Flatwoods, Pontotoc Ridge und Black Prairie), weshalb die Flora sehr artenreich ist. Aufgrund unserer Freilandarbeit, sowie eines umfangreichen Studiums der Fachliteratur und zahlreicher Herbariumsbelege in IBE und MISSA, waren wir in der Lage 1.148 Taxa (1.125 Arten, 7 Hybriden und 16 Unterarten oder Varietäten) aus 514 Gattungen und 160 Familien zu katalogisieren. 85% aller Taxa waren in Mississippi beheimatet. Der Verwaltungsbezirk Oktibbeha hat im Vergleich zu 3 anderen Verwaltungsbezirken im Mittelosten Mississippis die zweitgrößte Flora. Die Anzahl der Arten auf der Roten Liste Mississippis (vom Aussterben bedroht oder von besonderem Belang) übersteigt mit 66 weit die aller anderen Verwaltungsbezirke in der Region. Drei eingeschleppte Arten, *Ilex cornuta* Lindl. & Paxton, *Mahonia bealei* (Fortune) Carrière und *Nandina domestica* Thunb. werden hier zum ersten Mal von Mississippi erwähnt. Im weiteren Verlauf beschreiben wir außerdem im Detail 16 verschiedene Pflanzengesellschaften in 5 Lebensraumkategorien: Auenwälder, Hochlandwälder und Prairien, Aquatische Lebensräume, Sickerstellen und vom Menschen beeinflußte Lebensräume.

INTRODUCTION

Unlike other areas in the southeastern United States, Mississippi is largely unexplored botanically (Duncan 1953; Pullen 1966; Bryson & Carter 1992; Bryson et al. 1996; Sorrie & Leonard 1999; Alford 2001). To date, there is no comprehensive flora for the state, although there are 8 public herbaria (DSC, HGCRL, IBE, MISS, MISSA, MSCW, SWSL, University of Southern Mississippi) with combined holdings of more than 400,000 specimens (Holmgren et al. 1990). In addition, the Mississippi Museum of Natural Science (MMNS) maintains a herbarium of ca. 8,000 specimens, as well as a computer database of plant records, both of which are accessible to the public.

Historically, botanical explorations of Mississippi have been sporadic, and largely concentrated on the southern part of the state (Flint 1882a; Halsted 1891). The naturalist William Bartram traveled through parts of Mississippi in 1777 (Van Doren 1928), and the renowned botanist Thomas Nuttall reportedly collected plants around Natchez, Mississippi, in 1811 and 1820 (Graustein 1967). In 1840, John Claiborne began his exploration of the pine forests of southern Mississippi (McDaniel 1986); twenty years later, Hilgard (1860) published comments on the phytogeography of Mississippi. In the early twentieth century, Harper (1906, 1914) gave a superficial account of the pine barren vegetation of southern Mississippi based on his travels through that region. Lowe (1921) published the first checklist of vascular plants for the state.

In 1964, the Flora of Mississippi Project, funded by the National Science Foundation, was initiated by Samuel B. Jones, Jr., Thomas M. Pullen, and Ray Watson. A number of publications (Pullen et al. 1968a, 1968b; Jones et al. 1969; Watson 1969, 1970a, 1970b; Jones 1974a, 1974b, 1975a, 1975b, 1976a, 1976b) resulted, but the goal of a comprehensive floristic treatment was never achieved. A definitive treatment of the flora of Oktibbeha County has also been lacking so far, although floristic surveys have been performed for several Mississippi counties (Flint 1882b; Ferrari 1970; Morgan 1979; Meeks 1984; Morris 1987;

Winstead 1990; MacDonald 1996; Alford 2001), as well as other selected areas (Lassetter 1968; Massey 1974; Carter 1978; McCook 1982; Moore 1993). Hilgard (1860) stated: "With the Flatwoods of Octibbeha [sic] county, I am not personally acquainted," and the floristic literature for Oktibbeha County remains sparse. In the first published checklist of Mississippi plants, Lowe (1921) cites several vascular plant collections from Oktibbeha County, among them many species considered rare today by the Mississippi Natural Heritage Program (MNHP). However, the first botanical work dealing explicitly with the flora of Oktibbeha County was a survey of liver- and hornworts (Woods 1964). In recent years, some of the rare plant communities found in Oktibbeha County have been studied (Morris et al. 1993; Leidolf & McDaniel 1998).

The objectives of this study were to develop an annotated checklist of vascular plants and bryophytes (excluding Bryopsida) for Oktibbeha County. In addition, we wanted to provide information on habitat association and abundance of the plant species included in this checklist. In doing so, we hope to establish a botanical baseline for ecological research in this area, while at the same time making an important contribution to the recently revived Flora of Mississippi Project (e.g., Bryson & Carter 1992).

STUDY AREA

Location and Description of Oktibbeha County

Oktibbeha County is located in east-central Mississippi, approximately 200 km northeast of the state capital Jackson, and ca. 60 km west of the Mississippi-Alabama state line. It covers an area of approximately 118 km^2, and is bordered by 6 other counties: Lowndes County to the east, Winston and Noxubee Counties to the south, Webster and Choctaw Counties to the west, and Clay County to the north (Fig. 1). The county seat of Starkville is located 10 km northeast of the geographic center of Oktibbeha County, at the junction of State Highway 25 and U.S. Highway 82. Mississippi State University (MSU) and the Mississippi Agricultural and Forestry Experiment Station are located 2.5 km east of Starkville (Fig. 1). Starkville is the largest town in Oktibbeha County, followed by Maben and Sturgis (Brent 1973).

Climate

The climate of Oktibbeha County is warm and humid, and influenced by the subtropical latitude, the extensive landmass to the north, and the warm temperatures of the Gulf of Mexico (Brent 1973). Annual precipitation averages 141.86 cm, with monthly precipitation ranging from 8.23 cm in October to 15.24 cm in March (Table 1). Winter and spring are the wettest seasons of the year, with fall being the driest. Snow is rare and remains on the ground for short durations only (Brent 1973). Temperatures in Oktibbeha County range from an average low of 5.2°C in January to an average high of 27.0°C in July (Table 1). The average annual number of frost-free days (above 0°C) is 226 (Brent 1973).

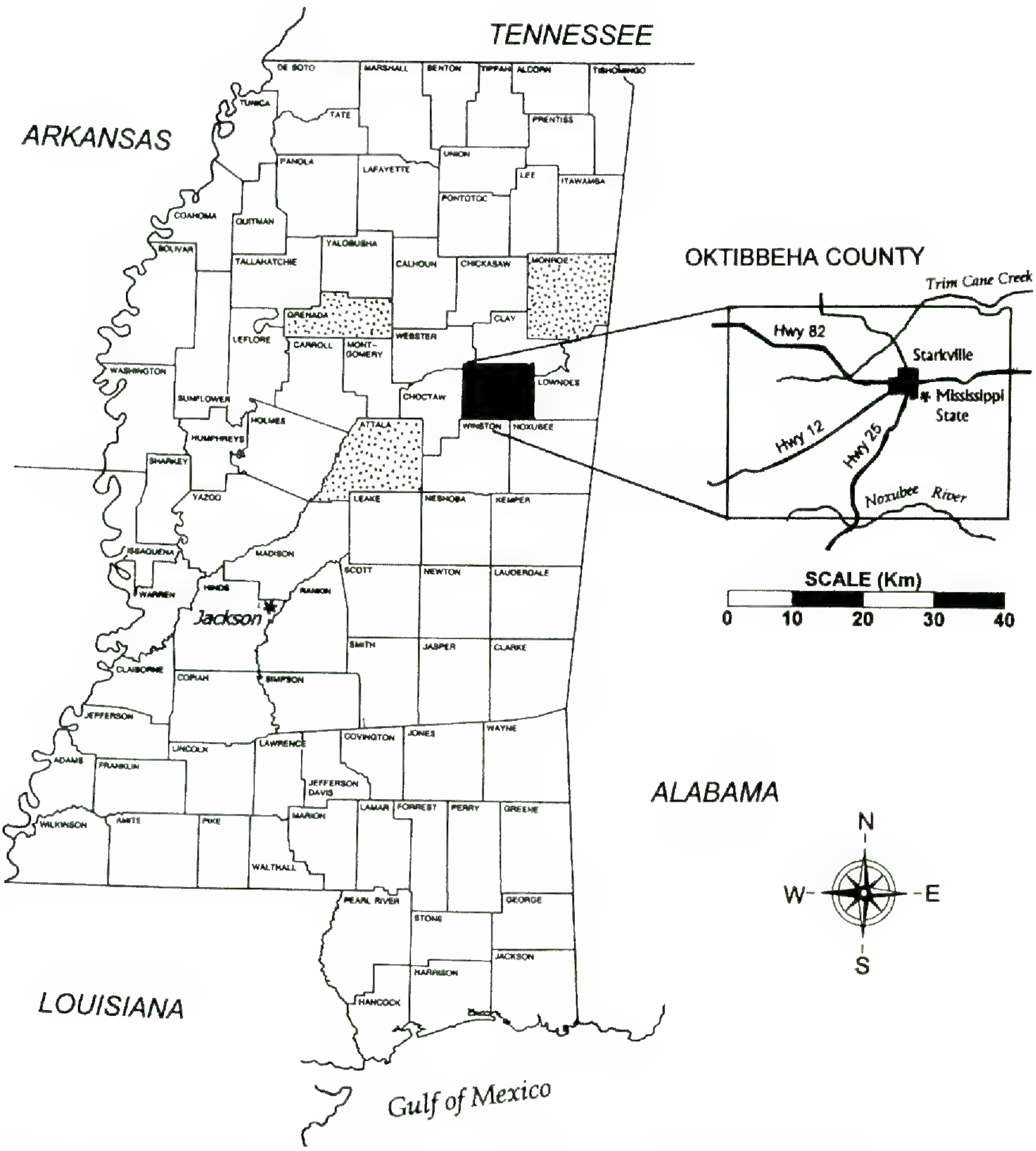


FIG. 1. Map of Mississippi, showing counties, and general location of study area and areas with which comparisons are made. Enlargement shows study area, Oktibbeha County.

Topography, Physiography, Geology, and Soils

Oktibbeha County is located within the Hilly Coastal Plain physiographic province (Fenneman 1938), a predominantly pine (*Pinus* spp.)-covered region in the southeastern United States. Elevation in the county ranges from 50 m a.s.l. in the Tibbe Creek floodplain in the northeastern corner of the county to 180 m a.s.l. in the southwestern corner of the county. The county is mapped on the 7.5' series U.S. Geological Survey topographic maps Artesia, Bluff Lake, Bradley, Cedar Bluff, Crawford West, Double Springs, Longview, Maben, Pheba, Starkville, Sturgis, and West Point. Oktibbeha county is drained into the Tombigbee River

TABLE 1. Climate data for Oktibbeha County, Mississippi, based on data from the U.S. Department of Agriculture, Natural Resources Conservation Service, National Water and Climate Center, for West station, 1961–1990.

	Temperature (°C)			
Month	Avg. daily maximum	Avg. daily minimum	Average daily	Avg. rainfall (cm)
January	10.7	-0.5	5.2	13.51
February	13.4	1.6	7.4	12.40
March	18.4	6.2	12.3	15.24
April	23.6	11.0	17.3	14.43
May	27.6	15.4	21.5	11.76
June	31.3	19.5	25.4	9.52
July	32.8	21.3	27.0	12.55
August	32.6	20.7	26.6	8.58
September	29.6	17.6	23.6	9.78
October	24.2	10.7	17.4	8.23
November	18.4	6.2	12.3	10.80
December	12.8	1.5	7.2	15.06
Total:	22.9	10.9	16.9	141.86

by two major drainage systems: the Tibbe Creek system, which includes Sun Creek, Trim Cane Creek, Sand Creek, and Catalpa Creek, drains the northern half of the county; in the southern part of the county, the Noxubee River and its tributaries drain southeastward into the Tombigbee River (Fig. 1, Brent 1973).

Oktibbeha County is situated among three physiographic regions (Fig. 2). The eastern part of the county extends into the Black or Northeastern Prairie Region. Vegetation in this region is influenced by alkaline soils derived from underlying chalk of Upper Cretaceous age, including Demopolis, a bedded chalk consisting primarily of calcite, with small additions of montmorillonitic clay, mica, and sand; and Prairie Bluff, a mixture of bedded chalk and calcareous sandstone (Brent 1973). To the west, the Black Prairie is bordered by the Pontotoc Ridge; here, the Prairie Bluff chalk is, on the highest points, overlain with red clays derived from the Ripley formation, also of Upper Cretaceous age and made up of calcareous sands and clays (Brent 1973). The western portion of the county lies within the Interior Flatwoods, a 5 to 20 km wide band of level to slightly hilly lands (Hilgard 1860). This region was formed from geologic formations of Tertiary age, which include Clayton, a heterogenous formation consisting of sand, calcareous sandstone, chalk conglomerate, clay, or marl; Porters Creek, made up of montmorillonitic clays; Wilcox, a formation consisting of quartz sand, silty clay, bauxitic clay, and clay-ball conglomerates; and Naheola. In addition to these substrates, recent alluvial deposits, as well as older terrace deposits, may be found in the stream valleys and flood plains (Brent 1973).

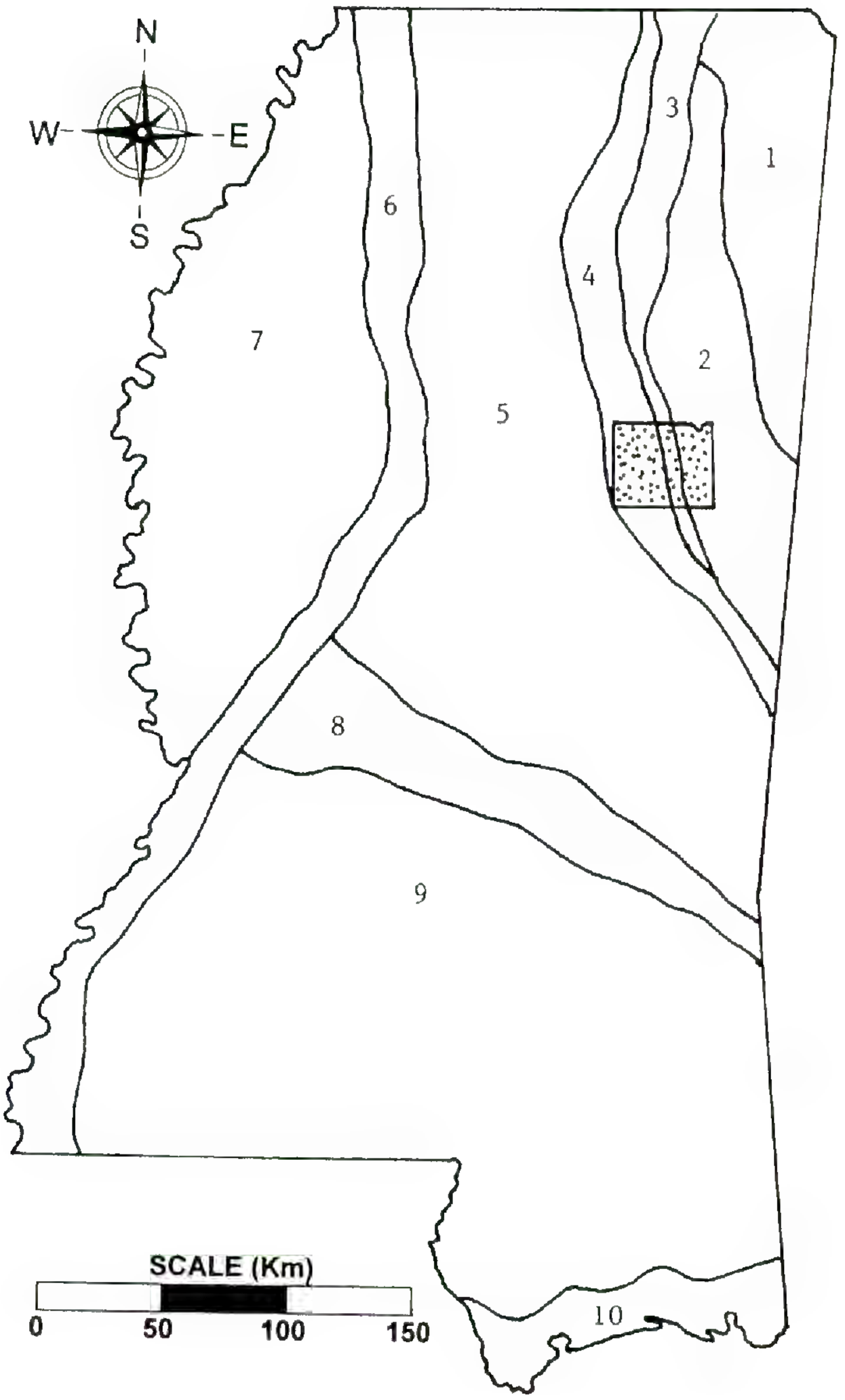


Fig. 2. Map of Mississippi, showing location of study area Oktibbeha County and Mississippi physiographic regions. 1 = Tennessee River Hills 2 = Black Prairie 3 = Pontotoc Ridge 4 = Interior Flatwoods 5 = North Central Plateau 6 = Loess Bluff Hills 7 = Mississippi Alluvial Valley (Yazoo-Mississippi Delta) 8 = Jackson Prairie 9 = Longleaf Pine Belt 10 = Coastal Pine Meadows (after Lowe 1921).

The soils found in Oktibbeha County have been grouped into 10 soil associations (Brent 1973). Three associations consisting of nearly level, somewhat poorly to moderately well-drained soils, occur in floodplains in the Black Prairie (Leeper-Marietta-Catalpa) and the Interior Flatwoods (Mathiston-Urbo, Mantachie-Mathiston-Ochlockonee) physiographic regions. The remaining 7 associations are found on uplands. The most prominent upland soil association in the Black Prairie is the Kipling-Savannah-Oktibbeha Association, which covers 21% of the county and consists of somewhat poorly to moderately well-drained soils with clayey subsoils or moderately well-drained soils with loamy

subsoils and a fragipan. The Kipling-Sumter-Gullied Land Association, made up of somewhat poorly drained to well-drained soils with clayey subsoils developed from chalk that are severely gullied in some areas, is another interesting soil association of the Black Prairie: although it covers only 4% of the county, it is of botanical interest because of the chalk outcrops it includes. Prominent upland soil associations of the Interior Flatwoods physiographic province include the Longview-Falkner-Prentiss Association, which consists of somewhat poorly to moderately well-drained soils with loamy to clayey subsoils and covers 25% of the county, and the Stough-Prentiss-Myatt Association, which is made up of poorly to moderately well-drained soils with loamy subsoils and covers 8% of the county. The narrow ridgetops and sidelopes in the extreme western portion of Oktibbeha County are dominated by the Maben-Ruston-Savannah Association, consisting of moderately well- to well-drained soils with loamy subsoils (Brent 1973).

Presettlement Vegetation

The first white settlers did not arrive in the area of present-day Oktibbeha County until 1820, when Presbyterian missionaries built a mission in Mayhew. Oktibbeha County was created through an act of the state legislature on 23 December 1833, after the land had been acquired from the Choctaw Indians in the Treaty of Dancing Rabbit Creek on 27 September 1830 (Brent 1973). By the 1840 census, 4,276 people lived in Oktibbeha County, of which 1,702 were engaged in agriculture (U.S. Census Bureau 1840). The best available information on pre- and early settlement vegetaion in the area comes from Hilgard's (1860) seminal report on the phytogeography of Mississippi, which was based on his travels through the state in the early to mid-1850's. Although Hilgard (1860) did not visit Oktibbeha County, his comments on the Prairie Belt of neighboring Lowndes County, as well as on the Flatwoods of neighboring Chickasaw, Calhoun, and Choctaw Counties (which, at the time, included present-day Clay and Webster Counties) provide a reasonable estimate of Oktibbeha County's early settlement vegetation. At the time, Oktibbeha County had a population of 9,171, with 20% of its land area (23,655 ha) in improved farmland, distributed among 560 farms (U.S. Census Bureau 1850). However, it is likely that most of this farmland, and therefore, most of the population, was concentrated in the Black Prairie part of the county, with the Interior Flatwoods "... thus far but thinly settled ..." (Hilgard 1860:281).

Based on Hilgard's observations, it is apparent that presettlement vegetation of the Black Prairie was dominated by grasslands, which were "... level, or very gently undulating tracts, possessing a deep black, heavy soil, on which timber is very much scattered or altogether wanting ..." (Hilgard 1860:261). Chalk outcops were already an important component of the landscape at the time, "... forming 'bald prairies' and 'bald hilltops'—in which the limestone is too close

to the surface to allow of the growth of trees or other deep rooted plants, and not unfrequently forms white areas many acres across in extent, strewn with fossils (especially oysters) washed out of the mass, and only here and there a patch of *Verbena* [probably *V. bipinnatifida* and *V. simplex*], or *Cassia* (*C. obtusifolia, occidentalis, marilandica*)." (Hilgard 1860:77). Interspersed with these tracts of open prairie and chalk outcrops were "... tracts of a more rolling surface, mostly with shallow, pale, light soil, timbered with the common upland Oaks—Spanish ("*Red*") [*Quercus falcata*], Post [*Q. stellata*], Black Jack [*Q. marilandica*], and sometimes Red and Black ("Black") [*Q. velutina*] and Scarlet ("Spanish") Oak [*Q. coccinea*] ..." (Hilgard 1860:261). Hilgard's (1860) statements regarding Black Prairie vegetation are echoed by Lowe (1921:32): "The region has a gently rolling surface, and was originally prairies, having only here and there scattered patches of trees, except on the stream bottoms, which supported heavy growths of timber. This Prairie Belt is now largely in cultivation, but some timber remains in the bottoms."

Little can be said regarding the presettlement vegetation of the Pontotoc Ridge in Oktibbeha County. Hilgard (1860) crossed the Pontotoc Ridge far to the north of Oktibbeha County, so his observations may not be entirely representative. However, speaking of the Pontotoc Ridge in general, he referred to it as a "... narrow belt of fertile land underlaid [sic] by marl beds" (Hilgard 1860:266), and further commented on the variable nature of the Pontotoc Ridge vegetation, which ranges from open prairie-like communities in calcareous areas to mesophytic upland hardwood forests on moist, north-facing exposures and xeric upland hardwood forests on sandstone ridges. Lowe (1921:35) noted that the red soils of the Pontotoc Ridge "... support a rich growth ..." and that "[t]he plants of the Pontotoc Ridge present decided differences from those of the prairies lying to the east, and the tertiary flatwoods on the west."

Presettlement vegetation of the Interior Flatwoods in the western part of Oktibbeha County likely consisted of upland hardwood forest dominated by *Quercus stellata* Wangenh., *Q. marilandica* Muenchh., and *Pinus* spp., with *Liriodendron tulipifera* L. common on sideslopes and in hollows. *Vaccinium* spp. was abundant in the understory; herbacious ground cover was sparse. Moving east and south into the Interior Flatwoods, these upland species were gradually replaced by *Quercus alba* L., *Q. falcata* Michx., *Q. rubra* L., and *Carya* spp., with the ground "... covered with a fine growth of grass." (Hilgard 1860:280-282).

Land Use, Present-day Vegetation, and Disturbance

Prior to 1923, most (> 75%) of Oktibbeha County had been farmed at one time or another, with the main crop being cotton (*Gossypium* sp.; U.S. Census Bureau 1920, Brent 1973). As recent as 1964, 67% of the county's land area was farmland (Brent 1973); today, in part due to such government programs as the Conservation Reserve Program (U.S. Department of Agriculture [USDA] Farm Ser-

vice Agency) and the Stewardship Incentives Program (USDA Forest Service), forestry and recreation have supplanted agriculture as the primary land uses in the county. As of 1997, there were 329 farms covering 35,000 ha, or 30% of Oktibbeha County (USDA National Agricultural Statistics Service [NASS], http://www.nass.usda.gov). On the other hand, forest land now makes up 64% of the county, with 28% pine, 58% hardwood, and 14% mixed forest (Mississippi Forestry Commission, http://www.mfc.state.ms.edu). The John W. Starr Memorial Forest and Noxubee National Wildlife Refuge (NWR), which represent extensive areas of forested land and provide a variety of recreational opportunities, are partially located in Oktibbeha County. The remainder of the county is urban land.

With the exception of the John W. Starr Memorial Forest and Noxubee NWR, most areas of the county have been heavily impacted by anthropogenic disturbance, including agriculture and forestry, and the condition of the vegetation is correspondingly poor. Disturbance from agriculture is most evident in the Black Prairie physiographic region, with much of the native prairie vegetation having been replaced by crop- and pasture land. Despite the fact that a sizeable percentage of land has been taken out of cultivation over the last decades, these lands have shown a tendency to grow up in trees rather than returning to their original grassland vegetation (Lowe 1921, Leidolf & McDaniel 1998). Furthermore, the few remnant prairies that remain today are subject to a combination of anthropogenic and natural disturbances, including exotic species invasions, recreation, and erosion.

Disturbance from forest operations is a major factor affecting the vegetation of the Interior Flatwoods. This is especially true for privately owned forest land, where management appears to be driven primarily by economic considerations; accordingly, treatments are often severe, with minimal rotation lengths. On the John W. Starr Memorial Forest and Noxubee NWR, forest management more closely mimics natural processes and generally follows Mississippi Best Management Practices that attempt to minimize the effect of forest operations on land condition.

METHODS

We made vascular plant and bryophyte collections from February 1994 to 1996. Collecting trips were conducted on a regular basis, at an average rate of one trip per week, covering all parts of Oktibbeha County. We processed all collections using standard field and herbarium techniques (Blake 1932; Smith 1971; Jones & Luchsinger 1986). Field notes included information on habitat, species association, relative abundance, and natural history/ecology. Whenever possible, we collected duplicate vouchers, except in the case of rare species. A complete set of voucher specimens has been deposited at IBE, with partial sets distributed to

BRIT, FR, UTC, and the Mississippi State University College of Forest Resources Herbarium (MSUSFR).

After completion of field work, we conducted a complete herbarium review of existing records at IBE and MISSA. All other herbaria in the state were judged to have too few specimens from Oktibbeha County to warrant close attention. Specimens from Oktibbeha County were verified and annotated. Where available, we incorporated label information on physiographic region, habitat of occurrence, and relative abundance into our annotated checklist. We examined 710 specimens in this manner. We also reviewed pertinent literature and published checklists for records from Oktibbeha County and, after critical evaluation, incorporated them into the checklist. Since the specimens upon which the reports are based were usually not seen, only the reference is provided.

Sources used for identification and verification of specimens, as well as for nomenclatural reference, included Allen (1992), Bailey and Bailey (1976), Barkworth et al. (In preparation), Britton and Brown (1970), Burkhart (1969), Correll and Johnston (1970), Cronquist (1980), Davenport (1988), Godfrey and Wooten (1979, 1981), Great Plains Flora Association (1986), Hitchcock (1951), Isley (1990), Krüssmann (1977), Lellinger (1985), Morris (1989), Radford et al. (1968), Shinners (1962), and Steyermark (1963). Where used, herbarium acronyms follow Holmgren et al. (1990). Abbreviations of botanical journals follow Bridson and Smith (1991).

RESULTS AND DISCUSSION

General

We documented 1,148 plant taxa (1,125 species, 7 hybrid taxa, and 16 infraspecific taxa) from Oktibbeha County, belonging to 160 families and 514 genera. Of these taxa, 976 (85%) are native (Table 2). Seventeen families are represented by 5 genera or more (Table 3); 46 genera are represented by 5 taxa or more (Table 4). Noteworthy collections include 3 introduced species documented in a naturalized state from Mississippi for the first time: *Ilex cornuta* Lindl. & Paxton, *Mahonia bealei* (Fortune) Carrière, and *Nandina domestica* Thunb. [The last species has since been reported from Amite County, Mississippi (Alford 2001)]. All 3 species are used frequently for landscaping by MSU and were encountered in a mesophytic upland hardwood forest in the Pontotoc Ridge physiographic region adjacent to campus. Given the common characteristics of their seeds (all 3 species produce fleshy berries readily consumed by birds [Dirr 1990]), animals, specifically birds, represent the most likely disperal vector.

Compared to 3 other counties in east-central Mississippi, Oktibbeha County has the second largest documented vascular flora. It has 17% and 11% more vascular plant taxa than Attala (Winstead 1990) and Grenada County (Morris 1987), respectively, and 14% less vascular plant taxa than Monroe County (MacDonald 1996). Compared to these 3 counties, Oktibbeha County has the highest species

TABLE 2. Taxonomic summary for the checklist of plants of Oktibbeha County, Mississippi.

Division/Class[a]	Families[b]	Genera[b]	Species and lesser taxa[c]		
			Native	Introduced	Total
Bryophyta[d]	12	14	22	0	22
Hepaticopsida	11	13	21	0	21
Anthocerotopsida	1	1	1	0	1
Equisetophyta	0	0	0	0	0
Lycopodiophyta	2	3	5	0	5
Polypodiophyta	10	12	14	1	15
Pinophyta	3	3	4	0	4
Magnoliophyta	133	482	931	171	1102
Magnoliopsida	105	368	624	114	738
Liliopsida	28	114	307	57	364
Total	**160**	**514**	**976**	**172**	**1148**

[a] Nomenclature follows Flora of North America Editorial Committee (1993).
[b] Counts are based on families and genera as recognized by Brummitt (1992).
[c] Counts are based on species and lesser taxa as recognized by Kartesz (1994) and Barkworth et al. (In preparation).
[d] Bryopsida was not included in this study.

TABLE 3. Plant families[a] in Oktibbeha County, Mississippi, represented by ≥5 genera[b] (in decreasing order of importance; followed by number of species and lesser taxa[c] in parentheses).

Asteraceae–57 (140)	Lamiaceae–14 (24)	Cyperaceae–8 (100)	Euphorbiaceae -5 (19)
Poaceae–56 (159)	Brassicaceae–13 (20)	Boraginaceae–6 (10)	Malvaceae–5 (7)
Fabaceae–36 (75)	Rosaceae–13 (28)	Caryophyllaceae–6 (8)	
Scrophulariaceae–20 (34)	Rubiaceae–10 (22)	Ranunculaceae–7 (21)	
Apiaceae–19 (24)	Orchidaceae–9 (17)	Caprifoliaceae–5 (6)	

[a] Nomenclature follows Brummitt (1992).
[b] As recognized by Brummitt (1992).
[c] As recognized by Kartesz (1994) and Barkworth et al. (In preparation).

richness in 5 out of 20 representative flowering plant families; for an additional 11 families, Oktibbeha County ranks second in species richness (Table 5). The 1,103 species of vascular plants documented from Oktibbeha County comprise 38.7% of all vascular plant species known to occur in Mississippi (USDA, Natural Resources Conservation Service [NRCS] Plants database, http://plants.usda.gov).

Rare/Protected Species

Oktibbeha County features a large number of rare and protected species. Sixty-seven species are currently listed as sensitive (MNHP 2002a, 2002b; Table 6), far exceeding the number of state-listed species reported from 3 other counties in east-central Mississippi (Table 5). Statewide, Oktibbeha County ranks 4th in the number of sensitive species, after Jackson, Tishomingo, and Perry Counties

TABLE 4. Plant genera[a] in Oktibbeha County, Mississippi, that are represented by ≥5 taxa[b] (in decreasing order of importance).

Carex–57	*Carya*–10	*Silphium*–7	*Lactuca*–5
Dichanthelium–24	*Hypericum*–10	*Smilax*–7	*Poa*–5
Juncus–17	*Polygonum*–9	*Spiranthes*–7	*Rhus*–5
Quercus–17	*Trifolium*–9	*Sporobolus*–7	*Rhynchospora*–5
Cyperus–15	*Asclepias*–8	*Verbena*–7	*Rubus*–5
Paspalum–15	*Galium*–8	*Agalinis*–6	*Rumex*–5
Aster–14	*Helianthus*–8	*Fimbristylis*–6	*Scirpus*–5
Solidago–12	*Panicum*–8	*Ludwigia*–6	*Sisyrinchium*–5
Desmodium–11	*Crataegus* 7	*Vicia*–6	*Vaccinium*–5
Eragrostis–11	*Eleocharis* 7	*Amaranthus*–5	*Viola*–5
Eupatorium–11	*Lespedeza*–7	*Chamaesyce*–5	
Ranunculus–11	*Oenothera*–7	*Euphorbia* 5	

[a] Nomenclature follows Brummitt (1992).
[b] As recognized by Kartesz (1994) and Barkworth et al. (In preparation).

(MMNS database, June 2002). Four species are also listed as either threatened or rare by the USDA Forest Service (Kral 1983, Table 6); of these, *Apios priceana* B.L. Rob. is currently the only species listed as federally threatened (5 January 1990, 55 FR 433) under the Endangered Species Act (16 USCS §1531 et seq.). Nineteen species in the families Araliaceae, Cactaceae, and Orchidaceae are also afforded special protection as Appendix II species under the Convention on International Trade in Endangered Species of Wild Flora and Fauna (27 UST 1087; TIAS No. 8249; Table 6). The most significant discovery in the category of rare and protected species is that of a small population of *Alisma subcordatum* Raf. at Oktibbeha County Lake, a plant species previously considered to be of only historical occurrence in Mississippi.

Plant Communities

We recognized 16 different plant communities that can be grouped into 5 broad categories: bottomland forests, upland forests and prairies, aquatic communities, seepage areas, and human-influenced communities.

BOTTOMLAND FORESTS

Bottomland forests are formed by alluvial processes of erosion and sediment deposition that result in diverse topographical formations such as ridges, sloughs, flats, and terraces. Topographical variation results in a variety of flooding regimes; thus, small differences in topography effect large differences in edaphic conditions, and the resulting differences in plant associations are obvious. The two main types of bottomland forest we recognized, bottomland hardwood forest and swamp forest, owe their respective plant communities primarily to differences in flooding regime. Because Oktibbeha County lacks major streams, the extent of bottomland sites is limited.

TABLE 5. Species richness of selected taxonomic groups in 4 counties of east-central and north-central Mississippi.

Taxon[a]	Attala Co.[b]	Grenada Co.[c]	Monroe Co.[d]	Oktibbeha Co.
Bryophyta	91	N/A[e]	51	N/A[f]
Anthocerotopsida	1	N/A[e]	1	1
Hepaticopsida	24	N/A[e]	12	21
Bryopsida	66	N/A[e]	38	N/A[f]
Equisetophyta	1	2	1	0
Lycopodiophyta	4	2	4	5
Polypodiophyta	19	19	19	15
Pinophyta	5	4	4	4
Magnoliophyta	916	969	1253	1079
Magnoliopsida	643	661	871	731
Apiaceae	17	23	32	24
Asteraceae	107	116	156	137
Brassicaceae	9	10	21	20
Ericaceae	9	7	12	7
Euphorbiaceae	12	11	21	19
Fabaceae	67	70	85	74
Fagaceae	23	21	24	18
Hypericaceae	10	9	13	12
Juglandaceae	10	12	12	11
Lamiaceae	22	24	28	23
Polygonaceae	14	15	17	15
Ranunculaceae	13	12	25	20
Rosaceae	34	27	40	28
Rubiaceae	16	15	22	22
Scrophulariaceae	24	26	29	34
Liliopsida	273	308	382	348
Cyperaceae	79	90	112	98
Juncaceae	12	14	18	19
Liliaceae (sensu lato[g])	27	23	32	36
Orchidaceae	16	19	17	17
Poaceae	98	121	146	146
Total:	**1036**	**N/A[e]**	**1332**	**N/A[f]**
Total (vascular only):	**945**	**996**	**1281**	**1103**
State-listed species[h]:	**13**	**42**	**50**	**67**

[a]Nomenclature follows Brummitt (1992), Flora of North America Editorial Committee(1993), and Barkworth et al. (In preparation).—[b]Winstead (1990). [c]Morris (1987).—[d]MacDonald (1996).—[e]Did not assess Bryophyta; therefore, a comparison can not be made with other counties.—[f]Did not assess Bryopsida; therefore, a comparison can not be made with other counties. –[g]Including Alliaceae, Amaryllidaceae, Asparagaceae, Convallariaceae, Hemerocallidaceae, Hyacinthaceae, Hypoxidaceae, Liliaceae, Melanthiaceae, Smilacaceae, and Trilliaceae.—[h]Mississippi Natural Heritage Program (2002a, 2002b); Mississippi Museum of Natural Science database (June 2002).

TABLE 6. Rank/status of protected plant species known to occur in Oktibbeha County, Mississippi.

Species[a]	MNHP Rank[b]		ESA[c]	CITES[d]	USDA[e]
	State	Global			
Aesculus glabra Willd.	S2?	G5			
Agalinis pseudaphylla (Pennell) Shinners	S2	G1G2			T
Alisma subcordatum Raf.	SH	G4G5			
Amphiachyris dracunculoides (DC.) Nutt.	S1	G4G5			
Apios priceana B.L. Rob.	S1	G2	T		R
Armoracia lacustris (A. Gray) Al-Shehbaz &Bates	S1S2	G4?			
Asarum canadense L.	S2S3	G5			
Asclepias hirtella (Pennell) Woodson	S2	G5			
Asclepias purpurascens L.	S1	G4G5			
Aster ericoides L.	S2	G5			
Astragalus canadensis L. var. *canadensis*	S2	G5			
Bouteloua curtipendula (Michx.) Torr. in Marcy	S3S4	G5			
Camassia scilloides (Raf.) Cory	S2S3	G4G5			
Carex gracilescens Steud.	S2S3	G5?			
Carex jamesii Schwein.	S1S2	G5			
Carex laxiflora Lam.	S1	G5?			
Carex meadii Dewey	S3S4	G4G5			
Carex microdonta Torr. & Hook.	S2?	G4			
Carex stricta Lam.	S2	G5			
Carya laciniosa (F. Michx.) G. Don	S2S3	G5			
Carya leiodermis Sarg.	S2S3	G5			
Coelorachis cylindrica (Michx.) Nash	S1	G4G5			
Corallorhiza wisteriana Conrad					II
Crataegus calpodendron (Ehrh.) Medik.	S?	G5			
Dasistoma macrophylla (Nutt.) Raf.	S3S4	G4			
Delphinium tricorne Michx.	S2	G5			
Dodecatheon meadia L.	S2	G5			
Echinacea purpurea (L.) Moench	S3S4	G4			
Erythronium albidum Nutt.	S2	G5			
Evax prolifera Nutt. ex DC.	S1	G5			
Evonymus atropurpureus Jacq.	S2S3	G5			
Frasera caroliniensis Walter	S2S3	G5			
Fraxinus quadrangulata Michx.	S2	G5			
Hexalectris spicata (Walter) Barnhart	S2	G5			II
Hybanthus concolor (T.F. Forst.) Spreng.	S2	G5			
Juncus filipendulus Buckley	S3S4	G5			
Lilium superbum L.	S3S4	G5			
Linum sulcatum Riddell	S3S4	G5			
Listera australis Lindl.					II
Lobelia appendiculata A.DC.	S2S3	G4G5			
Malaxis unifolia Michx.					II
Menispermum canadense L.	S3S4	G5			
Muhlenbergia glabriflora Scribn.	S?	G4?			
Nemastylis geminiflora Nutt.	S2	G4			

Species[a]	MNHP Rank[b] State	Global	ESA[c]	CITES[d]	USDA[e]
Neptunia lutea (Leavenw.) Benth.	S3S4	G5			
Oenothera triloba Nutt.	SU	G4			
Onosmodium molle Michx. ssp. *hispidissimum* (Mack.) B. Boivin					R
Ophioglossum engelmannii Prantl	S1	G5			
Opuntia humifusa (Raf.) Raf.				II	
Osmorhiza longistylis (Torr.) DC.	S3	G5			
Panax quinquefolius L.	S3	G3G4		II	
Penstemon tenuiflorus Pennell	S2S3	G3?			
Perideridia americana (Nutt. ex DC.) Reichenb.	S1S2	G4			
Platanthera ciliaris (L.) Lindl.				II	
Platanthera clavellata (Michx.) Luer				II	
Platanthera cristata (Michx.) Lindl.	S3	G5		II	
Polytaenia nuttallii DC.	S2	G5			
Ponthieva racemosa (Walt.) C.Mohr	S2?	G4G5		II	
Prenanthes aspera Michx.	S2	G4?			
Ptelea trifoliata L.	S3S4	G5			
Quercus macrocarpa Michx.	S2	G5			
Rhamnus lanceolata Pursh	S2	G5			
Sedum pulchellum Michx.	S1	G5			
Spiranthes cernua (L.) Rich.				II	
Spiranthes lacera (Raf.) Raf.	S3S4	G5		II	
Spiranthes magnicamporum Sheviak	S2S3	G4		II	
Spiranthes ovalis Lindl.	S2S3	G5?		II	
Spiranthes praecox (Walt.) S.Watson				II	
Spiranthes tuberosa Raf.				II	
Spiranthes vernalis Engelm. & A. Gray				II	
Staphylea trifolia L.	S3	G5			
Taenidia integerrima (L.) Drude	S1	G5			
Thalictrum debile Buckley	S1S2	G2			R
Tipularia discolor (Pursh) Nutt.				II	
Tomanthera auriculata (Michx.) Raf.	S1	G3			
Triosteum angustifolium L.	S3	G5			
Triphora trianthophora (Sw.) Rydb.	S2S3	G3G4		II	
Ulmus serotina Sarg.	S3?	G4			
Uvularia floridana Chapm.	S1	G3			

[a]Nomenclature follows Kartesz (1994) and Barkworth et al. (In preparation).—[b]Mississippi Natural Heritage Program (2002a, 2002b) rank: Critically imperiled globally (G1), imperiled globally (G2), rare and local throughout range, found locally in a restricted range, or vulnerable to extinction (G3), apparently secure globally, but may be rare in parts of its range (G4), demonstrably secure globally (G5), with "?" indicating uncertainty about or inexactness of a rank. State (S) ranks are same as global ranks, except in that "state" is substituted for "global", with SH, SJ, and S? indicating historical occurrence but suspected to be extant, uncertain rank, and unranked, respectively.—[c]Endangered Species Act, 16 USCS §1531 et seq. T= threatened species, i.e., a species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.—[d]Convention on

1. Bottomland hardwood forests.—Bottomland hardwood forests in Oktibbeha County are found primarily in the Interior Flatwoods physiographic region, where they occur on seasonally flooded sites associated with creeks and minor streams. The high foliage volume of these forests gives credence to their reputation for high productivity. Depending on mode of establishment and disturbance history (e.g., logging), bottomland hardwood forests in Oktibbeha County may have multiple layers, including overstory, midstory (subcanopy), and woody and herbaceous understory layers (the latter may be weakly developed or lacking in forests subject to recent logging); however, due to variations in tree height and extensive growth of such lianas as *Rhus radicans* L., *Bignonia capreolata* L., *Ampelopsis* spp., *Parthenocissus quinquefolia* (L.) Planch., *Vitis* spp., and *Smilax* spp., stratification may not be readily apparent at any given site. In addition to the vegetation layers already mentioned, unique and locally important features include palmetto [*Sabal minor* (Jacq.) Pers.] thickets and dense cane [*Arundinaria gigantea* (Walter) Muhl.] brakes.

The overstory of bottomland hardwood forests is generally dominated by oaks (*Quercus* spp.) with species composition depending on moisture. From wet to dry, dominants include *Q. lyrata* Walter, *Q. michauxii* Nutt., *Q. nigra* L., *Q. phellos* L., and *Q. pagoda* Raf. Co-dominants include *Q. alba* L., *Q. falcata* Michx., *Q. laurifolia* Michx., *Q. rubra* L., *Q. shumardii* Buckley, *Q. stellata* Wangenh., *Q. texana* Buckley, *Fagus grandifolia* Ehrh., *Liquidambar styraciflua* L., *Carya carolinae-septentrionalis* (Ashe) Engl. & Graebn., *C. cordiformis* (Wangenh.) K. Koch, *C. glabra* (Mill.) Sweet, *C. ovalis* (Wangenh.) Sarg., *C. ovata* (Mill.) K. Koch, *C. tomentosa* (Lam. ex Poir.) Nutt., and *Liriodendron tulipifera* L.; noteworthy is *Carya leiodermis* Sarg., which is listed as imperiled to rare and local in the state (S2S3, MNHP 2002a). Common intermediate/midstory trees include *Acer rubrum* L., *Nyssa sylvatica* Marshall, *Celtis laevigata* Willd., *Ulmus americana* L., and *U. alata* Michx. Examples of small trees/large shrubs include *Asimina triloba* Dunal, *Ilex decidua* Walter, *Carpinus caroliniana* Walter, *Ostrya virginiana* (Mill.) K. Koch, *Rhododendron canescens* (Michx.) Sweet, *Aesculus pavia* L., *Hamamelis virginiana* L., *Lindera benzoin* (L.) Blume, *Sassafras albidum* (Nutt.) Nees, *Amelanchier arborea* (F. Michx.) Fernald, *Crataegus viridis* L., and *Planera aquatica* J.F. Gmel.; noteworthy records include *Ptelea trifoliata* L. and *Staphylea trifolia* L., which are listed as rare and local to apparently secure (S2S3) and rare and local (S3) in the state, respectively (MNHP 2002a, 2002b). The understory consists of a mixture of small shrubs, includ-

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Table 6 legend (continued)

International Trade in Endangered Species of Wild Fauna and Flora, 27 UST 1087; TIAS No. 8249. II – Appendix II species, i.e., (a) a species which, although not necessarily threatened with extinction, may become so unless trade is subject to strict regulations, or (b) a species which must be subject to regulation in order that trade in certain specimens of species referred to under (a) may be brought under effective control, i.e., species similar in appearance.—[e]USDA Forest Service Technical Publication R8-TP2 (Kral 1983). T = threatened, R = rare.

ing *Cornus stricta* Lam., *Vaccinium* spp., *Hydrangea quercifolia* W. Bartram, and *Itea virginica* L.; and herbs, including such ferns as *Botrychium biternatum* (Sav.) Underw. and *Onoclea sensibilis* L., such forbs as *Thaspium trifoliatum* (L.) A. Gray, *Dicliptera brachiata* (Pursh) Spreng., *Amsonia tabernaemontana* Walter, *Aristolochia tomentosa* Sims, *Pluchea camphorata* (L.) DC., *Solidago caesia* L., *Lobelia cardinalis* L., *Specularia biflora* (Ruiz & Pav.) Fisch. & C.A. Mey., *Desmodium canescens* (L.) DC., *D. cuspidatum* (Muhl. ex Willd.) DC. ex Loudon, *Vicia caroliniana* Walter, *Triadenum* spp., *Collinsonia tuberosa* Michx., *Lycopus virginicus* L., *Spigelia marilandica* L., *Ludwigia* spp., *Polygonum virginianum* L., *Epifagus virginiana* (L.) Baton, *Gratiola* spp., *Arisaema dracontium* (L.) Schott, *Commelina virginica* L., *Tradescantia virginiana* L., *Maianthemum racemosum* (L.) Link, and *Dioscorea villosa* L., and such graminoids as *Carex abscondita* Mack., *C. annectens* (E.P. Bicknell) E.P. Bicknell, *C. caroliniana* Schwein., *C. corrugata* Fernald, *C. flaccosperma* Dewey, *C. leavenworthii* Dewey, *C. longii* Mack., *C. louisianica* L.H. Bailey, *C. reniformis* (L.H. Bailey) Small, *C. typhina* Michx., *Cinna arundinacea* L., *Dichanthelium commutatum* (Schult.) Gould, *Leersia oryzoides* (L.) Sw., *L. virginica* Willd., *Panicum rigidulum* Bosc ex Nees in Mart., and *Paspalum repens* P.J. Bergius. *Pleopeltis polypodioides* (L.) E.G. Andrews & Windham var. *michauxiana* (Weath.) E.G. Andrews & Windham in Windham is a common epiphyte. Noteworthy understory species listed as sensitive (MNHP 2002a, 2002b) include *Dasistoma macrophylla* (Nutt.) Raf. (rare and local to apparently secure–S3S4), *Lilium superbum* L. (S3S4), *Muhlenbergia glabriflora* Scribn. (uncertain status–S?), *Spiranthes ovalis* Lindl. (imperiled to rare and local–S2S3), and *Triphora trianthophora* (Sw.) Rydb. (S2S3).

In the Black Prairie physiographic region, intensive agriculture has reduced once extensive bottomland hardwood forests to narrow gallery forests along small streams. Here, noteworthy species include *Quercus nigra* L., *Q. durandii* Buckley, *Carya tomentosa* (Lam. ex Poir.) Nutt., and *C. laciniosa* (F. Michx.) G. Don, which is listed as imperiled to rare and local in the state (S2S3, MNHP 2002a), in the overstory, with *Acer negundo* L., *Morus rubra* L., and *Ulmus rubra* Muhl. as intermediates. Shrubs include *Asimina triloba* (L.) Dunal, *Aesculus glabra* Willd., which is listed as possibly imperiled in the state (S2?, MNHP 2002a), *A. pavia* L., and *Prunus americana* Marshall; *Zizia aurea* (L.) W.D.J. Koch and *Eupatorium rugosum* are common herbaceous species.

2. *Swamp Forests.*—Swamp forests are permanently/semi-permanently inundated, and occur along the shallow margins of existing stream channels and old oxbow lakes that have been cut off from the main channel and have been partially silted in. Because of the small size of streams in Oktibbeha County, swamp forests are fairly limited in extent, with shallow water depths. Furthermore, they are restricted to the Interior Flatwoods physiographic region; the Black Prairie lacks streams of sufficient size. Frequency and duration of flood-

ing limits the species that can occur in swamp forests to extremely water-tolerant species. Germination for most species can only occur during periods of low water when the soil is exposed. Thus, in contrast to bottomland hardwood forests, swamp forests have a fairly sparse foliage profile. The overstory is dominated by *Quercus lyrata* Walter and, occasionally, *Taxodium distichum* (L.) L.C. Rich. Where present, water-tolerant shrubs and small trees (e.g., *Itea virginica* L. and *Vaccinium arboreum* Marshall) grow in small patches or singly and sparsely distributed. Because of the presence of standing water, ground vegetation is often absent, or may consist of small patches or scattered individuals of *Justicia ovata* (Walter) Lindau var. *lanceolata* (Chapm.) R.W. Long, *Bidens discoidea* (Torr. & A. Gray) Britton, *Polygonum densiflorum* Meisn., *Saururus cernuus* L., *Gratiola virginiana* L., *Pilea pumila* (L.) A. Gray, *Carex intumescens* Rudge, *C. joorii* L.H. Bailey, and *Leersia lenticularis* Michx.

Upland Forests and Prairies

1. Mesophytic upland hardwood forests.—Mesophytic upland hardwood forests are typically found in the Pontotoc Ridge physiographic region (see Morris et al. 1993); in the Interior Flatwoods, they rarely occur in the transition zone between upland pine/pine-mixed hardwood forests and bottomland forests; in the Black Prairie, they rarely occur in association with streams. Mesophytic upland hardwood forests are among the most diverse plant communities in Oktibbeha County; they are also home to some of the rarest plants in the county, featuring 18 species listed by the MNHP (2002a, 2002b), with many of them occurring only in this community. Mesophytic upland hardwood forests are characterized by an overstory of mixed deciduous hardwoods, including *Acer barbatum* Michx., *Fagus grandifolia* Ehrh., *Quercus alba* L., *Q. muehlenbergii* Engelm., *Q. shumardii* Buckley, *Q. stellata* Wangenh., *Carya carolinae-septentrionalis* (Ashe) Engl. & Graebn., *C. myristiciformis* (F. Michx.) Nutt., *Juglans nigra* L., *Liriodendron tulipifera* L., and *Platanus occidentalis* L.; noteworthy overstory species are *Fraxinus quadrangulata* Michx. and *Ulmus serotina* Sarg., which are listed as imperiled (S2) and possibly rare and local (S3?) in the state, respectively (MNHP 2002a). Conifers are absent from this community. Common under- and midstory trees and shrub include *Asimina triloba* (L.) Dunal, *Viburnum rufidulum* Raf., *Ostrya virginiana* (Mill.) K. Koch, *Cornus florida* L., *Rhododendron canescens* (Michx.) Sweet, *Aesculus pavia* L., *Tilia americana* L., and *Ulmus americana* L.; noteworthy mid- and understory associates are *Evonymus atropurpureus* Jacq. and *Crataegus calpodendron* (Ehrh.) Medik., which are listed as imperiled to rare and local (S2S3) and being of uncertain status (S?) in Mississippi, respectively (MNHP 2002a). Also common are lianas, including *Smilax bona-nox* L., *S. lasioneura* Hook., and *S. pulverulenta* Michx. The herbaceous plant layer is characterized by such forbs as *Sanicula odorata* (Raf.) K.M. Pryer & L.R. Phillippe, *Thaspium barbinode* (Michx.) Nutt.,

Heliopsis gracilis Nutt., *Podophyllum peltatum* L., *Cynoglossum virginianum* L., *Lithospermum latifolium* Michx., *Myosotis macrosperma* Engelm., *Cardamine concatenata* (Michx.) Sw., *Monotropa hypopithys* L., *Desmodium glutinosum* (L.) DC., *D. rotundifolium* DC., *Vicia caroliniana* Walter, *Spigelia marilandica* L., *Oxalis violacea* L., *Sanguinaria canadensis* L., *Anemone virginiana* L., *Thalictrum thalictroides* (L.) Eames & B. Boivin, *Agrimonia rostellata* Wallr., *Galium uniflorum* Michx., *Pedicularis canadensis* L., *Scrophularia marilandica* L., *Physalis heterophylla* Nees, *Viola* spp., *Arisaema* spp., *Lilium michauxii* Poir., *Tipularia discolor* (Pursh) Nutt., and *Trillium recurvatum* L.C. Beck, including such spring ephemerals as *Claytonia virginica* L., *Allium canadense* L., *Nothoscordum bivalve* (L.) Britton, *Uvularia sessilifolia* L., and *Hypoxis hirsuta* (L.) Coville; such graminoids as *Carex albicans* Willd. ex Spreng. var. *albicans*, *C. lupulina* Muhl. ex Willd., *C. striatula* Michx., *C. vulpinoidea* Michx., *Luzula echinata* (Small) F.J. Herm., *Agrostis perennans* (Walter) Tuck., *Chasmanthium latifolium* (Michx.) H.O. Yates, *C. sessiliflorum* (Poir.) H.O. Yates, *Dichanthelium boscii* (Poir.) Gould & C.A. Clark, *D. polyanthes* (Schult.) Mohlenbr., *Melica mutica* Walter, *Panium anceps* Michx., and *Poa autumnalis* Muhl. ex Elliott; as well as a diverse array of ferns and fern allies, including *Selaginella apoda* (L.) Spring, *Woodwardia areolata* (L.) T.Moore, *Polystichum acrostichoides* (Michx.) Schott, *Botrychium virginianum* (L.) Sw., *Osmunda cinnamomea* L., *O. regalis* L., *Pleopeltis polypodioides* (L.) E.G. Andrews & Windham var. *michauxiana* (Weath.) E.G. Andrews & Windham in Windham, *Athyrium filix-femina* (L.) Roth ex Mert. ssp. *asplenioides* (Michx.) Farw., and *Onoclea sensibilis* L.; noteworthy species from this association listed by MNHP (2002a, 2002b) are *Apios priceana* B.L. Rob. (critically imperiled–S1, federally threatened), *Asarum canadense* L. (imperiled to rare and local–S2S3), *Carex gracilescens* Steud. (S2S3), *C. jamesii* Schwein. (critically imperiled to imperiled–S1S2), *C. laxiflora* Lam. (S1), *Dasistoma macrophylla* (Nutt.) Raf. (rare and local to apparently secure–S3S4), *Frasera caroliniensis* Walter (S2S3), *Hexalectris spicata* (Walter) Barnhart (imperiled–S2), *Hybanthus concolor* (T.F. Forst.) Spreng. (S2), *Menispermum canadense* L. (S3S4), *Panax quinquefolius* L. (rare and local–S3), *Taenidia intergerrima* (L.) Drude (S1), *Thalictrum debile* Buckley (S1S2), and *Triosteum angustifolium* L. (S3).

2. *Xeric upland hardwood forests.*—In Oktibbeha County, xeric upland hardwood forests occur on dry secondary sandstone ridges in all 3 physiographic regions: on isolated hills scattered throughout the Black Prairie, on the Pontotoc Ridge, and in the transition zone from the Interior Flatwoods to the North-central Plateau physiographic region. Xeric upland hardwood forests in Oktibbeha County feature a unique complement of floristic elements, many of which are found in no other plant community in the county. In the Black Prairie, dominant overstory species include *Quercus marilandica* Muenchh., *Q. muehlenbergii* Engelm., *Q. velutina* Lam., *Liquidambar styraciflua* L., *Carya*

myristiciformis (F. Michx.) Nutt., and *C. tomentosa* (Lam. ex Poir.) Nutt.; noteworthy overstory species include *Quercus macrocarpa* Michx., which is listed as imperiled in the state (S2, MNHP 2002a). Common trees, shrubs, and woody vines of the mid- and understory are *Campsis radicans* (L.) Seem. ex Bureau, *Symphoricarpos orbiculatus* Moench, *Cornus drummondii* C.A. Mey., *Vaccinium arboreum* Marshall, *Amorpha fruticosa* L., *Sassafras albidum* (Nutt.) Nees, *Maclura pomifera* (Raf.) C.K. Schneider, *Crataegus engelmannii* Sarg., and *Zanthoxylum clava-herculis* L. Examples of characteristic herbaceous species are *Matelea gonocarpos* (Walter) Shinners, *Rudbeckia hirta* L., *Sagina decumbens* (Elliott) Torr. & A. Gray, *Desmodium ciliare* (Muhl. ex Willd.) DC., *Anagallis minima* (L.) Krause, *Ranunculus micranthus* Nutt., *Agrimonia rostellata* Wallr., *Fragaria virginiana* Duchesne, *Galium pilosum* Aiton, *Carex blanda* Dewey, *C. bushii* Mack., *C. umbellata* Schkuhr ex Willd., *Juncus tenuis* Willd., and *Luzula bulbosa* (Alph. Wood) Smyth & Smyth; noteworthy associates are *Erythronium albidum* Nutt. and *Spiranthes lacera* (Raf.) Raf., which are listed as imperiled (S2) and rare and local to apparently seure (S3S4) in the state, respectively (MNHP 2002a, 2002b). On the Pontotoc Ridge, characteristic woody species include *Campsis radicans* (L.) Seem. ex Bureau, *Lonicera sempervirens* L., *Quercus shumardii* Buckey, *Liquidambar styraciflua* L., *Carya myristiciformis* (F. Michx.) Nutt., *Sassafras albidum* (Nutt.) Nees, *Celtis laevigata* Willd., and *Smilax lasioneura* Hook., with *Antennaria plantaginifolia* (L.) Richardson, *Erigeron strigosus* Muhl. ex Willd., *Vicia minutiflora* F.Dietr., *Oxalis violacea* L., *Passiflora lutea* L., *Carex blanda* Dewey, *C. cephalophora* Muhl. ex Willd., *C. triangularis* Boeck, and *Juncus tenuis* Willd. being typical herbaceous species; *Echinacea purpurea* (L.) Moench, listed as rare and local to apparently secure in the state (S3S4, MNHP 2002a), is a noteworthy record from this association. The overstory of xeric upland hardwood forests in the Interior Flatwoods physiographic region is dominated by such species as *Quercus alba* L., *Q. falcata* Michx., *Q. nigra* L., *Q. pagoda* Raf., *Q. shumardii* Buckley, *Liquidambar styraciflua* L., and *Carya glabra* (Mill.) Sweet; *Campsis radicans* (L.) Seem. ex Bureau, *Sassafras albidum* (Nutt.) Nees, *Crataegus spathulata* Michx., and *Ampelopsis arborea* (L.) Koehne are common shrubs and vines of the mid- and understory. *Asclepias amplexicaulis* Small, *Matelea gonocarpos* (Walter) Shinners, *Euphorbia corollata* L., *Lespedeza virginica* (L.) Britton, *Pycnanthemum tenuifolium* Schrad., *Trichostema brachiatum* L., *Rhexia mariana* L. var. *mariana*, *Oxalis violacea* L., *Passiflora lutea* L., *Aureolaria flava* (L.) Farw., *Juncus tenuis* Willd., *Luzula bulbosa* (Alph. Wood) Smyth & Smyth, *Chasmanthium sessiliflorum* (Poir.) H.O. Yates, and *Dichanthelium boscii* (Poir.) Gould & C.A. Clark are typical herbaceous species.

3. *Pine Forests and Pine-Mixed Hardwood Forests.*—By and large, pine forests and pine-mixed hardwood forests in Oktibbeha County are restricted to the Interior Flatwoods physiographic region. The vast majority are intensively

managed pine plantations; naturally regenerated, unmanaged pine forests are rare. Management activities associated with timber production, including prescribed burns on variable rotations, pre-commercial and commercial thinning, and herbicide injection of undesirable hardwoods, result in reduced vegetation stratification and woody species richness in managed pine forests, and prevent naturally occurring plant succession. As a result, species composition differs significantly between managed and natural stands (Table 7). For example, natural pine or pine-hardwood forests, in addition to having a more diverse overstory, usually feature a well-developed midstory consisting of a diverse array of hardwoods, including *Acer rubrum* L., *Carya tomentosa* (Lam. ex Poir.) Nutt., *Cornus florida* L., *Liquidambar styraciflua* L., *Nyssa sylvatica* Marshall, *Diospyros virginiana* L., *Quercus* spp., *Sassafras albidum* (Nutt.) Nees, *Prunus serotina* Ehrh., and *Ulmus alata* Michx. (Table 7). Managed pine forests, on the other hand, where development of midstory vegetation is actively prevented, have only two vegetation layers: an overstory composed almost exclusively of *Pinus taeda* L. (and some *P. echinata* Mill.), and an understory that, much like that of pine-mixed hardwood forests, is characterized by a diverse assemblage of plants, including such graminoids as *Dichanthelium acuminatum* (Sw.) Gould & C.A. Clark ssp. *lindheimeri* (Nash) Freckmann & Lelong in ed., *D. laxiflorum* (Lam.) Gould, *Saccharum brevibarbe* (Michx.) Pers. ssp. *contortum* (Elliott) R.D. Webster, *S. giganteum* (Walter) Pers., and *Schizachyrium scoparium* (Michx.) Nash in Small, as well as the fire-adapted *Andropogon gerardii* Vitman and *Sorghastrum nutans* (L.) Nash in Small; a variety of forbs, including *Apocynum cannabinum* L., *Asclepias tuberosa* L., *Aster solidagineus* Michx., *Bidens aristosa* (Michx.) Britton, *Eupatorium* spp., *Euthamia tenuifolia* (Pursh) Nutt., *Liatris spicata* (L.) Willd., *Solidago* spp., *Chamaecrista fasciculata* (Michx.) Greene, *Lespedeza* spp., *Tephrosia virginiana* (L.) Pers., *Seymeria cassioides* (J.F. Gmel.) S.F. Blake, *Aletris aurea* Walter, and *Spiranthes tuberosa* Raf.; such lianas as *Rhus radicans* L., *Lonicera japonica* Thunb., *Gelsemium sempervirens* (L.) W.T. Aiton, *Vitis rotundifolia* Michx., *Smilax glauca* Walter, and *S. rotundifolia* L.; shrubs and small trees, including *Aralia spinosa* L., *Vaccinium* spp., *Hyperium hypericoides* (L.) Crantz, *Crataegus* spp., and *Rubus* spp.; and tree seedlings, inluding *Carya glabra* (Mill.) Sweet and *Quercus* spp. (Table 7). Noteworthy pine and pine-mixed hardwood forest associates include *Asclepias hirtella* (Pennell) Woodson and *Lobelia appendiculata* A.DC., which are listed as imperiled (S2) and imperiled to rare and local (S2S3) in the state, respectively (MNHP 2002a).

4. Prairies.—Betz (1977) defines a prairie as a vegetative community composed of native perennial grasses and other herbaceous plants, and in which grasses contribute much of the vegetative cover. Prairies in Oktibbeha County are located largely in the Black Prairie physiographic region, and are of the blackland type, so named after the deep mantle of fertile black soil high in organic

TABLE 7. Importance value[a] of under-, mid-, and overstory plant species in representative managed and unmanaged pine forests and pine-mixed hardwood forests, Oktibbeha County, Mississippi, Fall 1993 (data from Theriot et al. 1993)[b].

Species	Pine forest (managed)	Pine forest (unmanaged)	Pine-mixed hardwood forest
Understory			
Carya glabra (Mill.) Sweet	38.98	-	-
Lonicera japonica Thunb.	61.71	72.19	58.34
Rubus spp.	9.23	93.87	10.23
Smilax spp.	15.67	22.61	8.14
Solidago spp.	9.12	22.33	16.91
Rhus radicans L.	11.67	6.13	17.03
Ulmus alata Michx.	2.83	14.41	2.45
Misc. graminoids	17.73	16.19	2.58
Misc. forbs	17.69	15.13	47.51
Eupatorium spp.	-	37.14	3.62
Bidens spp.		-	11.13
Diospyros virginiana L.	14.02	-	6.10
Saccharum giganteum (Walter) Pers.	24.21	-	18.79
Lespedeza spp.	2.46	-	10.99
Panicum spp. (s.l.)	2.58	-	14.95
Pinus taeda L.	11.45	-	5.82
Quercus spp.	18.36	-	39.62
Vitis rotundifolia Michx.	28.60	-	11.09
Misc. tree seedlings	14.00	-	7.14
Total:	**300.00**	**300.00**	**300.00**
Midstory	*no midstory present*		
Diospyros virginiana L.		15.14	
Nyssa sylvatica Marshall		53.64	
Acer rubrum L.		32.70	9.36
Carya tomentosa (Poir.) Nutt.	-	54.76	6.44
Cornus florida L.	-	3.94	7.90
Liquidambar styraciflua L.		55.27	104.44
Pinus spp.	-	12.27	60.20
Quercus spp.		61.61	28.74
Ulmus alata Michx.	-	10.65	44.98
Juniperus virginiana L.	-	-	24.58
Prunus serotina Ehrh.	-	-	13.36
Total:	**0.00**	**300.00**	**300.00**
Overstory			
Pinus spp.	275.81	266.65	178.28
Quercus spp.	24.19	18.12	7.14
Liquidambar styraciflua L.	-	6.99	87.00
Juniperus virginiana L.		-	19.93
Ulmus alata Michx.	-		7.65
Acer rubrum L.	-	8.24	-
Total:	**300.00**	**300.00**	**300.00**

matter, which occurs over a substrate of Cretaceous chalk or marl (Foti 1989). Today, most native prairies in Oktibbeha County have been replaced by agriculture (Lowe 1921; Brent 1973), with only few relicts of this highly threatened ecoregion remaining along highway and powerline rights-of-way. Prairies are among the most diverse plant communities in Oktibbeha County, albeit the condition of the prairie vegetation is generally quite poor due to the extent of human disturbance. Prairies are also home to some of the rarest plants in the county, featuring 19 species listed by the MNHP (2002a, 2002b), with many of them occurring only in this community. Prairie habitats in Oktibbeha County are dominated by a complex of graminoids, composites, and legumes. Characteristic graminoids include *Carex basiantha* Steud., *C. cherokeensis* Schwein., *C. granularis* Muhl. ex Willd., *C. hirsutella* Mack., *C. muehlenbergii* Schkuhr ex Willd., *Scleria oligantha* Michx., *Juncus torreyi* Coville, *Andropogon glomeratus* (Walter) Britton, Sterns & Poggenb., *A. virginicus* L., *Aristida longespica* Poir. in Lam., *A. oligantha* Michx., *Bothriochloa laguroides* (DC.) Pilger in Engler ssp. *torreyana* (Steud.) Allred & Gould, *Dichanthelium depauperatum* (Muhl.) Gould, *Panicum virgatum* L., *Phalaris caroliniana* Walter, *Schizachyrium scoparium* (Michx.) Nash in Small, *Setaria parviflora* (Poir.) Kerguélen, and *Sporobolus vaginiflorus* (Torr. ex A. Gray) Alph. Wood. Common forbs are *Ruellia humilis* Nutt., *Apocynum cannabinum* L., *Asclepias* spp., *Aster* spp., *Cacalia plantaginea* (Raf.) Shinners, *Dracopis amplexicaulis* (Vahl) Cass., *Heterotheca camporum* (Greene) Shinners, *Liatris* spp., *Ratibida pinnata* (Vent.) Barnh., *Rudbeckia fulgida* Aiton, *Silphium* spp., *Solidago* spp., *Lithospermum canescens* (Michx.) Lehm., *Lobelia spicata* Lam., *Cuscuta pentagona* Engelm. var. *pentagona*, *Croton* spp., *Euphorbia* spp., *Tragia urticifolia* Michx., *Crotalaria sagittalis* L., *Dalea candida* Willd., *D. purpurea* Vent., *Sabatia angularis* (L.) Pursh, *Hypericum sphaerocarpum* Michx., *Monarda citriodora* Cerv. ex. Lag., *Anemone caroliniana* Walter, *Delphinium carolinianum* Walter ssp. *carolinianum*, *Ranunculus fascicularis* Muhl. ex Bigelow, *Potentilla simplex* Michx., *Hedyotis* spp., *Agalinis* spp., *Buchnera floridana* Gandog., *Penstemon digitalis* Nutt. ex Sims, *P. laevigatus* Aiton, *Verbena bipinnatifida* Nutt., *V. simplex* Lehm., *Manfreda virginica* (L.) Salisb. ex Rose, *Hypoxis hirsuta* (L.) Coville, and *Sisyrinchium albidum* Raf. In disturbed areas, such ruderal species as *Ambrosia psilostachya* DC., *A. trifida* L., *Iva annua* L., *Lactuca saligna* L., *Lepidium virginicum* L., *Medicago lupulina* L., and *Melilotus alba* Medik. may be evident. Noteworthy prairie species listed by MNHP (2002a, 2002b) include *Perideridia americana* (Nutt. ex DC.) Reichenb. (critically imperiled to imperiled–S1S2), *Amphiachyris*

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[a]The importance value is the sum of relative frequency, relative density, and relative dominance (Daubenmire 1968).—[b]Data for understory estimates based on 100 ft. of line transect per habitat type using the intercept method (Canfield 1942); data for mid- and overstory estimates based on 10 sample points per habitat type using the point-centered-quarter (PCQ) method (Cottam & Curtis 1956).

dracunculoides (DC.) Nutt. (critically imperiled–S1), *Aster ericoides* L. (imperiled–S2), *Evax prolifera* Nutt. ex DC. (S1), *Prenanthes aspera* Michx. (S2), *Neptunia lutea* (Leavenw.) Benth. (rare and local to apparently secure–S3S4), *Linum sulcatum* Riddell (S3S4), *Dodecatheon meadia* L. (S2), *Delphinium tricorne* Michx. (S2), *Agalinis pseudaphylla* (Pennell) Shinners (S2), *Penstemon tenuiflorus* Pennell (imperiled to rare and local–S2S3), *Tomanthera auriculata* (Michx.) Raf. (S1), *Carex jamesii* Schwein. (S1S2), *C. meadii* Dewey (S3S4), *C. microdonta* Torr. & Hook. (possibly imperiled–S2?), *Nemastylis geminiflora* Nutt. (S2), *Spiranthes magnicamporum* Sheviak (S2S3), and *Bouteloua curtipendula* (Michx.) Torr. in Marcy (S3S4); *Onosmodium molle* Michx. ssp. *hispidissimum* (Mack.) B. Boivin is considered rare by USDA Forest Service (Kral 1983). Further discussion of Black Prairie floristics in Oktibbeha County can be found in Leidolf and McDaniel (1998).

5. Prairie Cedar Woodlands.—Leidolf and McDaniel (1998) define a prairie cedar woodland as "...*Juniperus virginiana* L.-dominated patches of woody vegetation restricted to thin, highly erodible, calcareous soils over chalk ... that are often interspersed with areas of exposed chalk, giving them a glade-like appearance". Prairie cedar woodlands are commonly found in the Black Prairie physiographic region of Oktibbeha County. Leidolf and McDaniel (1998) suggested that the apparent abundance of this plant community is a rather recent feature, and linked it to the absence of natural disturbance. Lowe (1921) also noted that "... lands formerly in cultivation and now thrown out, show a strong tendency to grow up in trees, ..."

Characteristic tree and shrub species of this community include *Juniperus virginiana* L. var. *virginiana*, *Rhus aromatica* Aiton, *Ilex decidua* Walter, *Viburnum rufidulum* Raf., *Cornus drummondii* C.A. Mey., *Quercus marilandica* Muenchh., *Q. muehlenbergii* Engelm., *Q. stellata* Wangenh., *Sassafras albidum* (Nutt.) Nees, *Maclura pomifera* (Raf.) C.K. Schneid., *Morus rubra* L., *Fraxinus americana* L., *Ligustrum sinense* Lour., *Ceanothus americanus* L., *Rhamnus caroliniana* Walter, *Crataegus crus-galli* L., *C. engelmannii* Sarg., *Rosa carolina* L., *Rubus cuneifolius* Pursh, *Bumelia lycioides* (L.) Pers., *Celtis laevigata* Willd., *Ulmus alata* Michx., and *U. rubra* Muhl.; *Campsis radicans* (L.) Seem. ex Bureau, *Lonicera japonica* Thunb., *Berchemia scandens* (Hill) K. Koch, *Ampelopsis arborea* (L.) Koehne, *Parthenocissus quinquefolia* (L.) Planch., *Vitis aestivalis* Michx., and *Smilax bona-nox* L. are common lianas. Herbaceous vegetation is sparse and includes *Ruellia caroliniensis* (J.F. Gmel.) Steud., *Sanicula canadensis* L., *Euphorbia spathulata* Lam., *Apios americana* Medik., *Cocculus carolinus* (L.) DC., *Fragaria virginiana* Duchesne, *Carex bushii* Mack., *C. cherokeensis* Schwein., and *C. oxylepis* Torr. & Hook var. *pubescens* J.K. Underw.; occasionally ferns, such as *Asplenium platyneuron* (L.) Oakes and *Pleopeltis polypodioides* (L.) E.G. Andrews & Windham var. *michauxiana* (Weath.) E.G. Andrews & Windham in Windham can be found. A number of unique floristic elements

found in no other habitat in Oktibbeha County were also found: *Rhus toxicodendron* L., *Helianthus divaricatus* L., and *Panicum flexile* (Gatt.) Scribn. in Kearney. Noteworthy prairie cedar woodland species listed by MNHP (2002a, 2002b) include *Ophioglossum engelmannii* Prantl (critically imperiled–S1), *Neptunia lutea* (Leavenw.) Benth. (rare and local to apparently secure–S3S4), *Dodecatheon meadia* L. (imperiled–S2), *Rhamnus lanceolata* Pursh (S2), *Penstemon tenuiflorus* Pennell (imperiled to rare and local–S2S3), and *Ponthieva racemosa* (Walter) C.Mohr (possibly imperiled–S2?). Morris et al. (1993) and Leidolf and McDaniel (1998) provide additional comments on prairie cedar woodland floristics in Oktibbeha County.

6. Chalk Outcrops.—Chalk outcrops in Oktibbeha County are restricted to the Black Prairie physiographic region. They were first recognized as being floristically distinct by Hilgard (1860), who referred to them as "bald prairies". Leidolf and McDaniel (1998) defined chalk outcrops as "... areas of exposed chalk, with all of the overlying soil eroded away ...", and suggested that aggravated erosion during periods of intense cultivation may have been responsible for an apparent decline in native prairie grasslands accompanied by a simultaneous increase in the abundance of chalk outcrops. Because conditions for plant growth in this unique habitat are severe, chalk outcrops do not support a diverse plant community; however, they harbor floristic elements not found elsewhere in Oktibbeha County, including *Senecio obovatus* Muhl. ex Willd., *Chamaesyce humistrata* (Engelm.) Small, *C. serpens* (Kunth) Small, *Lespedeza procumbens* Michx., and *Mirabilis albida* (Walter) Heimerl. Due to ample rainfall and low evaporation, the ground is usually moist during winter and spring months, and colonies of the blue-green alga *Nostoc* sp. can occasionally be found; in the summer, harsher, drier conditions prevail. Plant species characteristic of this habitat type include both native prairie grassland remnants, and plants that colonize chalk outcrops after erosion. Commonly found trees and shrubs include *Juniperus virginiana* L. var. *virginiana*, *Rhus aromatica* Aiton, *Cornus drummondii* C.A. Mey., *Hypericum sphaerocarpum* Michx., *Ceanothus americanus* L., *Rhamnus caroliniana* Walter, and *Prunus angustifolia* Marshall. Characteristic herbs are *Amaranthus rudis* J.D. Sauer, *Asclepias viridis* Walter, *Aster patens* Aiton, *Brickelia eupatorioides* (L.) Shinners var. *eupatorioides*, *Coreopsis lanceolata* L., *Heterotheca camporum* (Greene) Shinners, *Liatris squarrosa* (L.) Michx., *Silphium laciniatum* L., *Lithospermum canescens* (Michx.) Lehm., *Brassica erucastrum* L., *Euphorbia corollata* L., *Dalea candida* Willd., *D. purpurea* Vent., *Sabatia angularis* (L.) Pursh, *Agalinis tenuifolia* (Vahl) Raf., *Verbena bipinnatifida* Nutt., *V. simplex* Lehm., and *Sisyrinchium albidum* Raf. Noteworthy members of this association listed by MNHP (2002a) are *Sedum pulchellum* Michx. (critically imperiled–S1), *Rhamnus lanceolata* Pursh (imperiled–S2), *Penstemon tenuiflorus* Pennell (imperiled to rare and local–S2S3), and *Nemastylis geminiflora* Nutt. (S2). Further discussions of chalk outcrop

floristics in Oktibbeha County are provided by Morris et al. (1993) and Leidolf and McDaniel (1998).

Aquatic Communities

Aquatic communities in Oktibbeha County include both such lotic systems as rivers, creeks, canals, and drainage ditches, and lentic systems, including lakes, ponds, and artificial impoundments. Vegetation in these communities is mostly restricted to narrow regions near the shore referred to as riparian areas. Riparian areas generally have higher species diversity than either the adjacent terrestrial or aquatic communities, because they serve as a transition between the two systems. They are also generally more productive because of periodic influxes of nutrients from seasonal floods, and favorable moisture conditions yearround. Species composition at any point in a riparian area is largely a function of the degree or periodicity of inundation from the adjacent stream (Mitsch & Gosselink 1986).

1. Rivers/Creeks.—We discuss here the flora associated with riparian areas immediately adjacent to the stream bank, including those species growing on banks, associated mud flats, and directly in the stream (emergents). Submergent species are generally absent in local streams, because the turbid water effectively prevents photosynthesis; where clear-water streams do exist (i.e., in the Black Prairie physiographic region) pH is likely too high for plant growth, and consequently, no submergent species were observed. As mentioned previously, there are no major alluvial systems in Oktibbeha County; thus extensive riparian swamp forests are not represented.

In the Interior Flatwoods physiographic region, streambank associations include such small trees and shrubs as *Quercus lyrata* Walter, *Planera aquatica* J.F. Gmel., *Salix nigra* Marshall, *Acer negundo* L., *Betula nigra* L., *Prunus serotina* Ehrh., and *Evonymus americanus* L., as well as such woody vines as the introduced *Lonicera japonica* Thunb., and herbaceous plants, including *Thaspium trifoliatum* (L.) A. Gray, *Aristolochia tomentosa* Sims, *Leersia virginica* Willd., and *Paspalum repens* P.J. Bergius; noteworthy members of this association include *Ptelea trifoliata* L., which is listed as rare and local to apparently secure in the state (S3S4, MNHP 2002b). Due to their ephemeral nature, mudflat communities in the Interior Flatwoods are generally limited to such herbaceous plants as *Lobelia cardinalis* L., *Lycopus virginicus* L., *Samolus valerandi* L. ssp. *parviflorus* (Raf.) Hultén, *Lindernia dubia* (L.) Pennell, *Mimulus alatus* Aiton, *Physalis virginiana* Mill., *Boehmeria cylindrica* (L.) Sw., and *Commelina virginica* L. Emergents are few, and include *Ammania coccinea* Rottb., *Hydrolea uniflora* Raf., and *Penthorum sedoides* L.

Streambank associations in the Black Prairie physiographic region are characterized by *Aesculus pavia* L., *Tilia americana* L., *Lonicera japonica* Thunb., *Apios americana* Medik., *Mimulus alatus* Aiton, and *Silphium perfoliatum* L.

Noteworthy streambank associates include *Aesculus glabra* Willd., which is listed as possibly imperiled in the state (S2?, MNHP 2002a), and was found exclusively on Catalpa silty clay loam. Common emergents are *Ludwigia peploides* (Kunth) Raven and *Juncus acuminatus* Michx.

2. *Canals/Drainage Ditches.*—Canals/drainage ditches include both artificial, human-made structures, such as irrigation canals and culverts, and semi-natural features, such as unimproved roadside ditches. These habitats vary considerably with respect to extent, seasonality, and speed of water flow; they include habitats subject to year-round water flow as well as ephemeral habitats. Like rivers and creeks, the vegetation associated with canals/drainage ditches can be separated into riparian species (i.e., those species growing on the banks) and emergent species; additionally, the flora of canals/drainage ditches includes a small number of submergent species.

In the Interior Flatwoods physiographic region, plants commonly found on canal and ditch banks include such small trees and shrubs as *Sambucus canadensis* L. *and Cephalanthus occidentalis* L., as well as such herbaceous species as *Justicia ovata* (Walter) Lindau var. *lanceolata* (Chapm.) R.W. Long, *Ptilimnium capillaceum* (Michx.) Raf., *Rotala ramosior* (L.) Koehne, *Ranunculus pusillus* Poir., *Dichanthelium polyanthes* (Schultes) Mohlenbr., *D. sphaerocarpon* (Elliott) Gould, and *Urochloa ramosa* (L.) T.Q. Nguyen; noteworthy bank species include *Muhlenbergia glabriflora* Scribn., which is listed as being of uncertain status in Mississippi (S?, MNHP 2002a). Dominant emergent species primarily include such obligate and facultative aquatic forbs, sedges, and rushes as *Physostegia angustifolia* Fern., *Mollugo verticillata* L., *Ludwigia* spp., *Penthorum sedoides* L., *Polygonum* spp., *Gratiola* spp., *Commelina virginica* L., *Carex flaccosperma* Dewey, *C. joorii* L.H. Bailey, *Cyperus odoratus* L., *C. strigosus* L., *Eleocharis* spp., *Fimbristylis* spp., *Rhynchospora corniculata* (Lam.) A. Gray, *Scirpus atrovirens* Willd., *Iris virginica* L., *Juncus* spp., and *Typha latifolia* L.; noteworthy emergents include *Alisma subcordatum* Raf., which is listed as being of historical occurrence in Oktibbeha County (SH, MNHP 2002a). Submergent species include *Callitriche heterophylla* Pursh and *Najas guadalupensis* (Spreng.) Magnus.

In the Black Prairie physiographic region, canal and ditch banks are characterized by *Sambucus canadensis* L., *Salix exigua* Nutt., *Rorippa sessiliflora* (Nutt.) Hitchc., *Apios americana* Medik., *Ranunculus pusillus* Poir., and *Dichanthelium ravenellii* (Scribn. & Merr.) Gould. Characteristic emergent species in the Black Prairie are *Physostegia angustifolia* Fern., *Ludwigia peploides* (Kunth) Raven, *Polygonum lapathifolium* L., *Lysimachia nummularia* L., *Commelina communis* L., *Carex frankii* Kunth, *Cyperus odoratus* L., *C. acuminatus* Torr. & Hook. ex Torr., *Eleocharis obtusa* (Willd.) Schult., *Scirpus pendulus* Muhl., *Juncus* spp., and *Typha* spp.

3. *Lakes/Ponds/Impoundments.*—All lakes and ponds in Oktibbeha County

are artificial impoundments formed by damming a river, creek, or other drainage. Only two sizable (>250 ha) examples are present, both in the Interior Flatwoods physiographic region: Oktibbeha County Lake and Bluff Lake (most of which is in neighboring Noxubee County). Most other lentic systems are less than 10 ha in size and completely surrounded by private land; thus the flora of these areas may be underrepresented in this document because of poor access. We were able to obtain a fair representation from one such smaller lake, Dorman Lake, which is on public land and also located in the Interior Flatwoods.

The flora of lakes and ponds can be discussed in terms of those species growing in the riparian zone, including the margin or bank, and associated mudflats; those growing in the littoral zone, i.e., the shallow part of the lake immediately adjacent to the shore, including emergents, submergents, rooted-floating, and free-floating species; and those growing in the profundal zone, i.e., the deeper or interior part of the lake, including rooted-floating and free-floating species.

Common species along the margins of lakes and ponds include such small trees and shrubs as *Baccharis halimifolia* L., *Betula nigra* L., *Itea virginica* L., *Cephalanthus occidentalis* L., which also occurs in standing water in mudflats and in the littoral zone, and *Salix humilis* Marshall, as well as herbaceous species, including *Baptisia alba* (L.) R.Br. var. *macrophylla* (Larisey) Isley and *Leptochloa panicoides* (J. Presl) Hitchc. Mudflat associates include *Eryngium prostratum* Nutt. ex DC., *Pluchea camphorata* (L.) DC., *Lobelia cardinalis* L., *Polygala mariana* Mill., *Polygonum aviculare* L., *Ranunculus abortivus* L., *Micranthemum umbrosum* (J.F. Gmel.) S.F. Blake, *Arisaema dracontium* (L.) Schott, *Cyperus erythrorhizos* Muhl., *Cinna arundinacea* L., *Juncus elliottii* Chapm., *Scirpus cyperinus* (L.) Kunth, *Echinodorus cordifolius* (L.) Griseb., and *Sagittaria platyphylla* (Engelm.) J.G. Sm. These last 3 species, along with *Hydrolea uniflora* Raf., *Ludwigia palustris* (L.) Elliott, *Polygonum* spp., *Eleocharis quadrangulata* (Michx.) Roem. & Schult., and *Juncus nodatus* Coville, are also representative emergent species. A noteworthy collection from this association is *Alisma subcordatum* Raf., which is listed as being of historical occurrence in Oktibbeha County (SH, MNHP 2002a).

As their name implies, rooted-floating plants are attached to the substrate, with leaves floating at the lake surface. Rooted-floating and submergent vegetation occurs from the lake margin to a depth of ca. 2 m in the littoral zone. In contrast, free-floating species, including *Azolla caroliniana* Willd. and *Spirodela polyrrhiza* (L.) Schleid., occur in both the littoral and the profundal zone, but generally are blown into clumps on the lee side of water bodies. Submergent species of the littoral zone include *Callitriche heterophylla* Pursh, *Utricularia gibba* L., *Najas minor* All., and *Zanichellia palustris* L. Representative rooted-floating plants are *Brasenia schreberi* J.F. Gmel., *Limnobium spongia* (Bosc) Rich. ex Steud., *Nelumbo lutea* Willd., *Nymphaea odorata* Aiton,

Potamogeton diversifolius Raf., and *P. nodosus* Poir. Frequently, dense vegetation mats formed by rooted-floating plants provide a substrate for other plants to grow hydroponically. However, no evidence of this was found in Oktibbeha County.

Seepage Areas

Seepage areas are highly localized habitats that occur on relatively thin soil covering an underlying hardpan or rock formation and that, depending on local soil conditions and vegetation, vary considerably with respect to the source and extent of water flow, acidity, and degree and duration of stagnation. However, with the exception of a small number of natural springs, most seepage areas in Oktibbeha County consist of small ground depressions along roadsides in the Interior Flatwoods physiographic region. They are fed by sub-lateral flow from associated pine forests and occur on sandy loams overlain by a thin layer of clay. Consequently, water flow is acidic and highly unpredictable, with very little stagnation occurring. Within the constraints imposed by the local species pool, the vegetation of seepage areas most closely resembles that of a southern pine bog. Characteristic plant species include ferns and fern allies, such as *Lycopodiella alopecuroides* (L.) Cranfill, *L. appressa* (Chapm.) Cranfill, *L. prostrata* (R.M. Harper) Cranfill, *Woodwardia areolata* (L.) T.Moore, and *Pteridium aquilinum* (L.) Kuhn var. *pseudocaudatum* (Clute) A.Heller; graminoids, including *Carex frankii* Kunth, *Cyperus polystachyos* Rottb., *C. rotundus* L., *Kyllinga odorata* Vahl, *Rhynchospora caduca* Elliott, *R. inexpansa* (Michx.) Vahl, *Panicum virgatum* L., and *Paspalum* spp.; as well as numerous forbs, including *Aster solidagineus* Michx., *Pityopsis graminifolia* (Michx.) Nutt., *Buchnera floridana* Gandog., *Ruellia caroliniensis* (J.F. Gmel.) Steud., *Drosera brevifolia* Pursh, *Eryngium prostratum* Nutt. ex DC., *E. yuccifolium* Michx., *Lysimachia ciliata* L., *Polygala nana* (Michx.) DC., *Aletris aurea* Walter, *Spiranthes cernua* (L.) Rich., *S. praecox* (Walter) S.Watson, and *Xyris torta* Small; noteworthy species from this association include *Platanthera cristata* (Michx.) Lindl., which is listed as rare and local in the state (S3, MNHP 2002a). Occasionally, the small shrub *Salix humilis* Marshall can be found. Where stagnant pools of water occur, *Callitriche heterophylla* Pursh may be found submergent.

Human-influenced Communities

1. Cultivated Fields.—As of 1997, 17,500 ha, or 15%, of Oktibbeha County was cropland (USDA NASS, http://www.nass.usda.gov). Due to its productive soils, most cropland in the county is located in the Black Prairie physiographic region. Crops commonly planted include corn (*Zea mays* L.), cotton, and soy bean (*Glycine max* [L.] Merr.). A variety of weedy species, both native and exotic, readily invades these cultivated fields. Common natives found in this habitat include such forbs as *Amaranthus* spp., *Ciclospermum leptophyllum* (Pers.) Sprague ex Britton & Wilson, *Aster pilosus* Willd. var. *pilosus*, *Helenium*

autumnale L., *Ipomoea lacunosa* L., *I. pandurata* (L.) G.Mey., *Myosotis verna* Nutt., *Rorippa sessiliflora* (Nutt.) Hitchc., *Sibara virginica* (L.) Rollins, *Chamaesyce* spp., *Oenothera laciniata* Hill., *Myosurus minimus* L., *Ranunculus hispidus* Michx. var. *hispidus*, and *Linaria canadensis* (L.) Chaz.; as well as graminoids, including *Juncus bufonius* L., *J. torreyi* Coville, *Digitaria ciliaris* (Retz.) Koel., *Panicum capillare* L., *Paspalum pubiflorum* Rupr. ex E.Fourn., and *Urochloa platyphylla* (Munro ex Wright) R.D. Webster. Frequently encountered exotic forbs are *Arctium minus* Bernh., *Ipomoea hederacea* Jacq., *Capsella bursa-pastoris* (L.) Medik., *Cerastium glomeratum* Thuill., *Spergula arvense* L., *Medicago arabica* (L.) Huds., *Vicia grandiflora* Scop., *Abutilon theophrasti* Medik., *Polygonum aviculare* L., *Rumex crispus* L., *Ranunculus arvensis* L., and *R. muricatus* L.; representative exotic graminoids include *Cyperus esculentus* L., *C. rotundus* L., *Cyonodon dactylon* (L.) Pers., *Echinochloa colona* (L.) Link, *E. muricata* (P.Beauv.) Fernald, *Lolium multiflorum* Lam., *Paspalum dilatatum* Poir. in Lam., *Poa annua* L., *Setaria faberi* R.A.W. Herm., and *Sorghum halepense* (L.) Pers.

2. *Grass/Forb Meadows.*—Plant species occurring in grass/forb meadows, which include hay fields, pastures, and wildlife food plots, have to withstand or escape the frequent grazing or mowing characteristic for this community. Some species escape this disturbance by growing close to the ground, such as *Galium pilosum* Aiton, *Hedyotis crassifolia* Raf., *Ranunculus pusillus* Poir., *Veronica persica* Poir., and *Kyllinga odorata* Vahl., whereas other species, such as *Panicum scoparium* Lam., *Trifolium arvense* L., or *T. pratense* L., persist even under heavy grazing. Another group of plants found in this community are early spring ephemerals, such as *Claytonia virginica* L. and *Nothoscordum bivalve* (L.) Britton.

Grass/forb meadow associations in the Interior Flatwoods physiographic region are characterized by such species as *Euthamia tenuifolia* (Pursh) Nutt., *Eupatorium rotundifolium* L., *Cardamine bulbosa* (Schreb. ex Muhl.) Britton, Sterns & Poggenb., *Cuscuta pentagona* Engelm. var. *pentagona*, *Euphorbia spathulata* Lam., *Hypericum punctatum* Lam., *Prunella vulgaris* L., *Trichostema brachiatum* L., *Hedyotis crassifolia* Raf., *Glyceria declinata* Bréb., and *Dichanthelium scoparium* (Lam.) Gould; moist depressions may hold such wetland species as *Ludwigia alternifolia* L., *L. hirtella* Raf., and *Gratiola neglecta* Torr.; noteworthy records from this association include *Asclepias hirtella* (Pennell) Woodson, which is listed as imperiled in the state (S2, MNHP 2002a).

In the Black Prairie physiographic region, species representative of grass/forb meadows include *Ruellia humilis* Nutt., *Silphium laciniatum* L., *Vernonia gigantea* (Walter) Trel. var. *gigantea*, *Lithospermum canescens* (Michx.) Lehm., *Opuntia humifusa* (Raf.) Raf., *Galium pilosum* Aiton, *Carex festucacea* Schkuhr ex Willd., and *Kyllinga odorata* Vahl; noteworthy collections from this association include *Armoracia lacustris* (A. Gray) Al-Shebaz & Bates and *Camassia*

scilloides Corey, which are listed as critically imperiled to imperiled (S1S2), and imperiled to rare and local (S2S3) in the state, respectively (MNHP 2002a).

3. *Roadsides.*—Roadsides are among the most interesting plant communities in Oktibbeha County, as they represent a conglomerate of floristic elements of diverse origins. Because roads are frequently associated with human habitation, both past and present, roadside plant communities often feature species that have escaped from or persist after cultivation. Examples in Oktibbeha County include *Catalpa bignonioides* Walter, *Wisteria sinensis* (Sims) DC., *Broussonetia papyrifera* (L.) L'Hér. ex Vent., *Populus alba* L., *Lycoris radiata* (L'Hér.) Herb., *Narcissus* spp., *Hemerocallis fulva* (L.) L., *Muscari neglectum* Guss. ex Ten., and *Belamcanda chinensis* (L.) DC. The high frequency of disturbance, e.g., mowing of rights-of-way, associated with roadsides also provides suitable habitat for a diverse array of native herbs and exotic weeds ("ruderals"). New introductions are likely to be seen first along roads that can provide far-reaching connections between seed source and suitable dispersal habitat. Examples of common native roadside species include *Bidens aristosa* (Michx.) Britton, *Cirsium horridulum* Michx., *Erigeron annuus* (L.) Pers., *Iva annua* L., *Senecio anonymus* Wood, *Acalypha virginica* L., *Chamaesyce maculata* (L.) Small, *Croton capitatus* Michx., *Desmanthus illinoensis* (Michx.) MacMill. ex B.L. Rob. & Fernald, *Lespedeza cuneata* (Dum.Cours.) G. Don, *Blephilia ciliata* (L.) Benth., *Hedeoma hispida* Pursh, *Prunella vulgaris* L., *Plantago rugelii* Decne., *Rumex hastatulus* Baldwin, *Carex frankii* Kunth, *C. triangularis* Boeck., *Dichanthelium laxiflorum* (Lam.) Gould & C.A. Clark, *D. scabriusculum* (Elliott) Gould & C.A. Clark, *Elymus virginicus* L., and *Tridens flavus* (L.) Hitchc. Exotics frequently encountered include *Daucus carota* L., *Torilis arvensis* (Huds.) Link, *Taraxacum officinale* Weber ex F.H. Wigg., *Capsella bursa-pastoris* (L.) Medik., *Lonicera japonica* Thunb., *Cerastium glomeratum* Thuill., *Medicago lupulina* L., *Trifolium repens* L., *Lamium* spp., *Verbena brasiliensis* Vell., *Bothriochloa pertusa* (L.) A.Camus, *Setaria parviflora* (Poir.) Kerguélen, and *Sorghum halepense* (L.) Pers. Whereas the species mentioned thus far can be found along roads throughout the county, roadside communities, to a large degree, also reflect the plant communities that immediately surround them. Thus, roadsides in the Interior Flatwoods often feature such species as *Boltonia diffusa* Elliott, *Elephantopus carolinianus* Raeusch., *Acalypha rhomboidea* Raf., *Desmodium paniculatum* (L.) DC., *Lespedeza capitata* Michx., *Hypericum lobocarpum* Gatt., *Rhexia mariana* L. var. *mariana*, *Phlox pilosa* L., *Polygala sanguinea* L., *Aletris aurea* Walter, *Spiranthes vernalis* Engelm. & A. Gray, *Paspalum floridanum* Michx., *P. laeve* Michx., *Tridens strictus* (Nutt.) Nash in Small, and *Tripsacum dactyloides* (L.) L.; noteworthy collections from this association include *Asclepias hirtella* (Pennell) Woodson and *Lobelia appendiculata* A.DC., which are listed as imperiled (S2) and rare and local to apparently secure (S3S4) in the state, respectively (MNHP 2002a). Typical Black Prairie roadside species are *Aster novae-angliae* L., *A.*

praealtus Poir. var. *praealtus*, *A. undulatus* L., *Ratibida pinnata* (Vent.) Barnhart, *Rudbeckia fulgida* Aiton, *Silphium laciniatum* L., *Specularia perfoliata* (L.) A.DC., *Oenothera speciosa* Nutt., *Anemone caroliniana* Walter, *Penstemon laevigatus* Aiton, *Panicum capillare* L., and *P. dichotomiflorum* Michx.; noteworthy records include *Dasistoma macrophylla* (Nutt.) Raf. (rare and local to apparently secure–S3S4), *Penstemon tenuiflorus* Pennell (imperiled to rare and local–S2S3), *Tomanthera auriculata* (Michx.) Raf. (critically imperiled–S1), and *Spiranthes magnicamporum* Sheviak (S2S3, MNHP 2002a, 2002b).

4. Urban Areas (including lawns).—The flora of urban areas is depauperate, and consists mostly of plants that have escaped from, are spreading from, or persist after cultivation; as well as weedy species that aggressively invade lawns, flower beds, sidewalks, and roadsides. Examples of local escapes include *Vinca major* L., *Ratibida columnifera* (Nutt.) Wooton & Standl., *Evonymus fortunei* (Turcz.) Hand.-Mazz., *Elaeagnus umbellata* Thunb., *Wisteria sinensis* (Sims) DC., *Populus alba* L., *Ailanthus altissima* (Mill.) Swingle, *Lycoris radiata* (L'Hér.) Herb., *Narcissus* spp., *Hemerocallis fulva* (L.) L., and *Hyacinthoides nonscripta* (L.) Chouard ex Rothm. Commonly found native species include such forbs as *Bowlesia incana* Ruiz & Pav., *Acmella oppositifolia* (Lam.) R.K. Jansen var. *repens* (Walter) R.K. Jansen, *Ambrosia trifida* L., *Hieracium gronovii* L., *Lactuca serriola* L., *Draba brachycarpa* Nutt. ex Torr & A. Gray, *Sagina decumbens* (Elliott) Torr & A. Gray, *Chamaesyce* spp., *Plantago* spp., *Rumex hastatulus* Baldwin, and *Ranunculus* spp.; as well as many graminoids, including *Cyperus* spp., *Fimbristylis annua* (All.) Roem. & Schult., *Kyllinga* spp., *Scirpus koilolepis* (Steud.) Gleason, *Juncus tenuis* Willd., *Axonopus fissifolius* (Raddi) Kuhlm., *Hordeum pusillum* Nutt., *Dichanthelium* spp., *Sphenopholis obtusata* (Michx.) Scribn., and *Urochloa ramosa* (L.) T.Q. Nguyen. Exotic weeds characteristic of urban areas include *Arctium minus* Bernh., *Centaurea cyanus* L., *Lactuca saligna* L., *Taraxacum officinale* Weber ex F.H. Wigg., *Youngia japonica* (L.) DC., *Brassica juncea* (L.) Czern., *Capsella bursa-pastoris* (L.) Medik., *Cardamine hirsuta* L., *Cerastium glomeratum* Thuill., *Stellaria media* (L.) Vill., *Medicago arabica* (L.) Huds., *Trifolium* spp., *Lamium* spp., *Sherardia arvensis* L., *Valerianella locusta* (L.) Betcke, *Verbena brasiliensis* Vell., and *Poa* spp.

ANNOTATED CHECKLIST

Species and lesser taxa are grouped by division, class, and family. Plant divisions and classes are arranged according to phylogeny following Flora of North America Editorial Committee (1993); families, and genera and species within families, are arranged alphabetically. Non-vascular plant family and genus concepts follow Schuster (1966, 1969, 1974, 1980) for Anthocerotopsida and Hepaticopsida. Vascular plant family and genus concepts follow Brummitt (1992). Nativity status is based on the USDA NRCS Plants database (http://

plants.usda.gov). Species names are followed by the authority, with abbreviations according to Brummitt and Powell (1992). In general, nomenclature follows Kartesz (1994), with the exception of Poaceae, which follow Barkworth et al. (In preparation). Synonyms are given in brackets where pertinent. The physiographic region/regions in which a species occurs is/are indicated by the abbreviations BP (Black Prairie), PR (Pontotoc Ridge), or IF (Interior Flatwoods), followed by the plant community/communities in which that species is found. Relative abundance within a plant community is listed as very abundant (AA), abundant (A), common (C), occasional (O), uncommon (U), rare (R), very rare (RR), or historical (H). A plant that is common, abundant, or very abundant, but local in distribution, is indicated with (l) following the abundance designation. The status of a species is indicated in **bold** as federally threatened (**FT**) or sensitive (**S**), which includes the designations critically imperiled (**S1**), imperiled (**S2**), rare and local (**S3**), apparently secure (**S4**), demonstrably secure (**S5**), of historical occurrence (**SH**), and of uncertain status (**SU**; MNHP 2002a, 2002b). This is followed by a literature citation or accession number, composed of collector name, collection number (with "R" indicating a recollection), and source/depository herbarium acronym (Holmgren et al. 1990). Collections of the senior author are cited first (no collector name given), followed by those of others (collector name given, in a list for first specimen only); absence of an herbarium acronym indicates the specimen is referenced at IBE. Species preceded by an asterisk (*) are non-native species. An ampersand (&) indicates the species is a new record for Mississippi.

BRYOPHYTA
HEPATICOPSIDA

CEPHALOZIACEAE

Cephalozia bicuspidata (L.) Dumort., IF, lakes/ponds/impoundments, U; Woods (1964)

CEPHALOZIELLACEAE

Cephaloziella hampeana (Nees) Schiffn. ex Loeske, IF, U; Woods (1964)

GEOCALYCACEAE

Chiloscyphus pallescens (Ehrh.) Dumort., IF, rivers/creeks, U; Woods (1964)

Lophocolea bidentata (L.) Dumort., IF, lakes/ponds/impoundments, U; Woods (1964)

Lophocolea heterophylla (Schrad.) Dumort., IF, lakes/ponds/impoundments, C; Woods (1964)

Lophocolea minor Nees, IF, lakes/ponds/impoundments, C; Woods (1964)

JUBULACEAE

Frullania eboracensis Gottsche, PR, mesophytic upland hardwood forests, C; Woods (1964)

Frullania inflata Gottsche, IF, lakes/ponds/impoundments, U; Woods (1964)

Frullania kunzei Lehm. & Lindenb., IF, lakes/ponds/impoundments, U; Woods (1964)

Frullania squarrosa (Reinw., Bl. & Nees) Dumort., PR, mesophytic upland hardwood forests, A; Woods (1964)

JUNGERMANNIACEAE

Solenostoma pumilum (With.) K. Müll. [= *Jungermannia pumila* With.], IF, rivers/creeks, U; Woods (1964)

LEJEUNEACEAE

Cololejeunea minutissima (Smith) Schiffn., BP, prairie cedar woodlands, O; Woods (1964)

Leucolejeunea clypeata (Schwein.) A. Evans, IF, bottomland hardwood forests, C; Woods (1964)

Leucolejeunea unciloba (Lindenb.) A. Evans, IF, pine forests, C; Woods (1964)

PALLAVACINIACEAE

Pallavacinia lyellii (Hook.) Carruth., IF, lakes/ponds/impoundments, U; Woods (1964)

PORELLACEAE

Porella platyphylloidea (Schwein.) Lindenb., PR, mesophytic upland hardwood forests, C; Woods (1964)

RICCIACEAE

Riccia fluitans L., IF, lakes/ponds/impoundments, A; Woods (1964)

Riccia hirta (Austin) Underw., IF, roadsides, U; Woods (1964)

Riccia membranacea Gottsche & Lindenb., IF, rivers/creeks, C; Woods (1964)

Riccia sullivantii Austin, IF, rivers/creeks, C; Woods (1964)

SCAPANIACEAE

Scapania nemorosa (L.) Dumort., IF, lakes/ponds/impoundments, C; Woods (1964)

SPHAEROCARPACEAE

Sphaerocarpus texanus Austin, IF, grass/forb meadows, C; Woods (1964)

ANTHOCEROTOPSIDA

ANTHOCEROTACEAE

Anthoceros punctatus L., IF, lakes/ponds/impoundments, U; Woods (1964)

LYCOPODIOPHYTA

LYCOPODIACEAE

Lycopodiella alopecuroides (L.) Cranfill, IF, seepage areas, C; *651*

Lycopodiella appressa (Chapm.) Cranfill, IF, seepage areas, roadsides, O/C; *482, 1557, McDaniel 24335*

Lycopodiella prostrata (R.M. Harper) Cranfill, IF, seepage areas, C; *530*

Lycopodium digitatum Dill. ex A. Braun, IF, pine forests, RR; McDaniel pers. obs.

SELAGINELLACEAE

Selaginella apoda (L.) Spring, IF, mesophytic upland hardwood forests, R; *914, 1298 (R914)*

POLYPODIOPHYTA

ASPLENIACEAE

Asplenium platyneuron (L.) Oakes, BP, IF, pine forests, prairie cedar woodlands, O; *619, 720, 879*, Evans (1978), Leidolf and McDaniel (1998)

AZOLLACEAE

Azolla caroliniana Willd., BP, lakes/ponds/impoundments (littoral/profundal–free-floating), A(I); McDaniel pers. obs.

BLECHNACEAE

Woodwardia areolata (L.) T. Moore, IF, mesophytic upland hardwood forests, pine-mixed hardwood forests, canals/drainage ditches (riparian–banks), seepage areas, O; *901, 1556*, Evans (1978), Jones et al. (1969), *McDaniel 22136, Ray 6793* (MISSA)

DENNSTAEDTIACEAE

Pteridium aquilinum (L.) Kuhn var. *pseudocaudatum* (Clute) A. Heller, IF, pine forests, seepage areas, O/A(I); *983, McDaniel 2442*

DRYOPTERIDACEAE

Polystichum acrostichoides (Michx.) Schott, PR, IF, mesophytic upland hardwood forests, O; *338*, Evans (1978), *H.B.B. s.n.* (MISSA), *McDaniel 28886*

OPHIOGLOSSACEAE

Botrychium biternatum (Sav.) Underw., PR, IF, bottomland hardwood forests, pine forests, O/C; *878, 971, Bennett s.n., Brooks 562*, Evans (1978), Theriot et al. (1993)

Botrychium virginianum (L.) Sw., BP, PR, mesophytic upland hardwood forests, O; *1330, 1350*, Jones et al. (1969), *McDaniel 31022*, Morris et al. (1993), *Tracy s.n.* (MISSA)

Ophioglossum crotalophoroides Walter; Evans (1978)

Ophioglossum engelmannii Prantl, BP, prairie cedar woodlands, A(I), **S1**; Evans (1978), *McDaniel 10583*

OSMUNDACEAE

Osmunda cinnamomea L., IF, mesophytic upland hardwood forests, O/C; *899, 1380 (R899)*, Evans (1978), Jones et al. (1969)

Osmunda regalis L., IF, mesophytic upland hardwood forests, O/C; *900, 1379 (R900)*

POLYPODIACEAE

Pleopeltis polypodioides (L.) E.G. Andrews & Windham var. *michauxiana* (Weath.) E.G. Andrews & Windham in Windham, BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, prairie cedar woodlands, O/C; *44*, *Beal s.n.* (MISSA), *Channell s.n.* (MISSA), Evans (1978), Jones et al. (1969), Leidolf and McDaniel (1998), Morris et al. (1993), *Ray 8005* (MISSA), Theriot et al. (1993)

THELYPTERIDACEAE

**Macrothelypteris torresiana* (Gaudich.) Ching [= *Thelypteris torresiana* (Gaudich.) Alston], IF, bottomland hardwood forests, R; Theriot et al. (1993)

WOODSIACEAE

Athyrium filix-femina (L.) Roth ex Mert. ssp. *asplenioides* (Michx.) Farw., IF, mesophytic upland hardwood forests, C; *460*, *659 (R460)*, *H.B.B. s.n.* (MISSA), Jones et al. (1969)

Onoclea sensibilis L., IF, bottomland hardwood forests, mesophytic upland hardwood forests, O/C; *335*, *913 (R335)*, Theriot et al. (1993)

PINOPHYTA

CUPRESSACEAE

Juniperus virginiana L. var. *virginiana*, BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, pine-mixed hardwood forests, prairies, prairie cedar woodlands, chalk outcrops, R/AA; *6*, *7*, *1605*, Bryson (1980), *Henry s.n.* (MISSA), Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

PINACEAE

Pinus echinata Mill., IF, pine forests, pine-mixed hardwood forests, O/C; *1377a*

Pinus taeda L., BP, IF, bottomland hardwood forests, pine forests, pine-mixed hardwood forests, prairie cedar woodlands, chalk outcrops, O; Leidolf and McDaniel (1998), Theriot et al. (1993)

TAXODIACEAE

Taxodium distichum (L.) L.C. Rich, IF, swamp forests, C; *Leidolf s.n.*

MAGNOLIOPHYTA
MAGNOLIOPSIDA

ACANTHACEAE

Dicliptera brachiata (Pursh) Spreng., IF, bottomland hardwood forests, A; *Smith 946*

Justicia ovata (Walter) Lindau var. *lanceolata* (Chapm.) R.W. Long, IF, bottomland hardwood forests, swamp forests, canals/drainage ditches (riparian–banks), seepage areas, C(I); *359*, *536*, *1577*, Theriot et al. (1993)

Ruellia caroliniensis (J.F. Gmel.) Steud., BP, IF, bottomland hardwood forests, prairie cedar woodlands, seepage areas, roadsides, O/C; *496*, *1561*, Leidolf and McDaniel (1998), Theriot et al. (1993)

Ruellia humilis Nutt., BP, prairies, grass/forb meadows, O/C; *366*, Leidolf and McDaniel (1998), *McDaniel 13447*, Morris et al. (1993)

Ruellia strepens L., BP, PR, mesophytic upland hardwood forests, roadsides, O/C; *278*, *McDaniel 31326*, Morris et al. (1993)

ACERACEAE

Acer barbatum Michx., PR, mesophytic upland hardwood forests, C(I); *1337*, Morris et al. (1993)

Acer negundo L., BP, PR, IF, bottomland hardwood forests, rivers/creeks (riparian–banks), O; *226*, *Askew 25*, Morris et al. (1993), Theriot et al. (1993)

Acer rubrum L., PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, pine-mixed hardwood forests, C; *25*, *35*, *129 (R25)*, Morris et al. (1993), Theriot et al. (1993)

AMARANTHACEAE

Amaranthus albus L., BP, cultivated fields; *MacDonald 10885*

Amaranthus hybridus L., BP, cultivated fields, C(I)/A; *896*, *Bryson 3448b*, *Gasparini 201*, *McDaniel 28083*

Amaranthus rudis J.D. Sauer, BP, chalk outcrops, cultivated fields, roadsides, C(I)/A; *682*, *815*, *Bryson 3450*, *McDaniel 22196*, *31332*

Amaranthus spinosus L., BP, IF, cultivated fields, grass/forb meadows, C(I); *897*, *Clonts 1406*

Amaranthus viridis L., BP, cultivated fields, C(I); *894*

ANACARDIACEAE

Rhus aromatica Aiton, BP, mesophytic upland hardwood forests, prairies, prairie cedar woodlands, chalk outcrops, A; *186, 389, 788 (R186), 1327 (R389), 1342 (R186)*, Leidolf and McDaniel (1998), *MacDonald 7528, McDaniel 25016*, Pullen et al. (1968b), *Smith 1410, 1896, 1936*

Rhus copallinum L., IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, O; *445*, Theriot et al. (1993)

Rhus glabra L., BP, PR, IF, pine forests, prairies, prairie cedar woodlands, roadsides, A(l); *301, 644*, Leidolf and McDaniel (1998), *McDaniel 13464, 31647*, Morris et al. (1993)

Rhus radicans L. [= *Toxicodendron radicans* (L.) Kuntze ssp. *radicans*], PR, IF, bottomland hardwood forests, pine forests, pine-mixed hardwood forests, C; *472*, Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

Rhus toxicodendron L. [= *Toxicodendron pubescens* Mill.], BP, prairie cedar woodlands, O; *431*

ANNONACEAE

Asimina triloba (L.) Dunal, BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, A(l) *120, 353 (R120), 666, Askew 31, Gordon 2059 (MMNS), Leidolf s.n.*, Morris et al. (1993), Theriot et al. (1993)

APIACEAE (UMBELLIFERAE)

Bowlesia incana Ruiz & Pav., PR, urban areas, A(l); *1215, Maddux 1287*

Chaerophyllum tainturieri Hook., BP, roadsides, C; *158*, Lowe (1921)

Ciclospermum leptophyllum (Pers.) Sprague ex Britton & Wilson, BP, cultivated fields; *Bryson 1349*

Cicuta maculata L., IF, seepage areas, A(l); *1543*

Cryptotaenia canadensis (L.) DC., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, pine-mixed hardwood forests, O; *308, 391, 1515*

Cynosciadium digitatum DC., BP, roadsides; *Sundell 1542*

**Daucus carota* L., BP, IF, prairies, roadsides, C; *239*, Leidolf and McDaniel (1998), Pullen et al. (1968b)

Eryngium prostratum Nutt. ex DC., IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, lakes/ponds/impoundments (riparian–mudflats), seepage areas, U; *334, 498, 561, 1585 (R334), Bryson 674, Copeland s.n.*

Eryngium yuccifolium Michx. var. *yuccifolium*, IF, seepage areas, R; *566, 653*

Osmorhiza longistylis (Torr.) DC., PR, **S3**; *Green s.n.* (MISSA)

Perideridia americana (Nutt. ex DC.) Reichenb., BP, prairies, **S1/S2**; *Brooks 150*

Polytaenia nuttallii DC., PR, **S2**; *Baker 57* (MISSA), *Lott s.n.* (MISSA)

Ptilimnium capillaceum (Michx.) Raf., BP, IF, bottomland hardwood forests, mesophytic upland hardwood forests, canals/drainage ditches (riparian–banks), seepage areas, O/C; *332, 464, Bryson 719, Clonts 818*

Ptilimnium nuttallii (DC.) Britt., BP, IF, seepage areas, grass/forb meadows, urban areas, O; *500, MacDonald 7289, McDaniel 13494*

Sanicula canadensis L., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, prairie cedar woodlands, O; *302, Bryson 720*, Leidolf and McDaniel (1998), Lowe (1921), Morris et al. (1993), Theriot et al. (1993)

Sanicula odorata (Raf.) K.M. Pryer & L.R. Phillippe, PR, mesophytic upland hardwood forests, O; Morris et al. (1993)

Sanicula smallii E.P. Bicknell, IF, mesophytic upland hardwood forests, O; *340*

Spermolepis inermis (Nutt. ex DC.) Mathias & Constance, BP, prairies, O/C; *1512, MacDonald 8719*

Taenidia integerrima (L.) Drude, PR, mesophytic upland hardwood forests, **S1**; *Gordon 2034*

Thaspium barbinode (Michx.) Nutt., PR, mesophytic upland hardwood forests, C; *Gordon 2037*

Thaspium trifoliatum (L.) A. Gray, BP, PR, IF, bottomland hardwood forests, rivers/creeks (riparian–banks), O; *356*, Lowe (1921), *McDaniel 24966*, Morris et al. (1993), Theriot et al. (1993)

**Torilis arvensis* (Huds.) Link, BP, PR, prairies, roadsides, C; *1502, Clonts 816, McDaniel 13461*, Pullen et al. (1968b)

Trepocarpus aethusae Nutt. ex DC., BP, canals/drainage ditches (riparian–banks), seepage areas, O; *313*, Lowe (1921)

Zizia aurea (L.) W.D.J. Koch, BP, bottomland hardwood forests, O; *105*

APOCYNACEAE

Amsonia ornata McDaniel in ed., BP, canals/drainage ditches (riparian–banks), seepage areas, A(I); *209, McDaniel 29755*

Amsonia tabernaemontana Walter, IF, bottomland hardwood forests, O; Leidolf pers. obs., Theriot et al. (1993)

Apocynum cannabinum L., BP, IF, prairies, pine forests, A(I); *1517, Brooks 130, McDaniel 13463*

Trachelospermum difforme (Walter) A. Gray, IF, bottomland hardwood forests, pine forests, C(I) *1497, Brooks 397*, Theriot et al. (1993)

**Vinca major* L., BP, urban areas, A(I); *1448*

AQUIFOLIACEAE

&**Ilex cornuta* Lindl. & Paxton, PR, mesophytic upland hardwood forests, R; *887*

Ilex decidua Walter, BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, pine-mixed hardwood forests, prairies, prairie cedar woodlands, chalk outcrops, roadsides, C; *38, 40, 946, Askew 69a, Clonts s.n.*, Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

Ilex opaca Aiton, BP, IF, bottomland hardwood forests, mesophytic upland hardwood forests, C; *951, Laird 22*, Theriot et al. (1993)

ARALIACEAE

Aralia spinosa L., IF, bottomland hardwood forests, pine forests, pine-mixed hardwood forests, roadsides, C(I); *586*, Theriot et al. (1993)

Panax quinquefolius L., BP, PR, mesophytic upland hardwood forests, R, **S3**; *Bryson 8830*, Morris et al. (1993), *Smith 1415*

ARISTOLOCHIACEAE

Aristolochia tomentosa Sims, IF, bottomland hardwood forests, rivers/creeks (riparian–banks), U; *Smith 542a*, Theriot et al. (1993), *Timme 5435*

Asarum canadense L., PR, mesophytic upland hardwood forests, C, **S2S3**; *Harrelson 21* (MISSA)

ASCLEPIADACEAE

Asclepias amplexicaulis Small, IF, xeric upland hardwood forests, R; *1546*

Asclepias hirtella (Pennell) Woodson, IF, pine forests, grass/forb meadows, roadsides, C(I), **S2**; *1563, Bryson 681, 6001, 7000, Ray 4751* (MISSA), *Stauffer s.n.* (MISSA)

Asclepias purpurascens L., **S1**; *Easley s.n.* (MISSA)

Asclepias tuberosa L., BP, IF, prairies, pine forests, roadsides, C(I); *291, 853, 1536, Bryson 679, 703*, Leidolf and McDaniel (1998), *McDaniel 31093*, Morris et al. (1993)

Asclepias variegata L., IF, roadsides; *Copeland s.n.*

Asclepias verticillata L., IF, bottomland hardwood forests, mesophytic upland hardwood forests, roadsides, U; *919, Clonts 827, Gordon 2039*

Asclepias viridiflora Raf., BP, prairies, R/C; *1508, 1526, 1602*, Leidolf and McDaniel (1998), *McDaniel 13455, 31098*, Morris et al. (1993)

Asclepias viridis Walter, BP, IF, prairies, chalk outcrops, roadsides, C/A; *204, 1457 (R204), 1525, Brooks 148, Carter 3017*, Leidolf and McDaniel (1998), *McDaniel 29757, 31035, 31067*, Morris et al. (1993), *Sundell 1536*

Matelea gonocarpos (Walter) Shinners, BP, PR, IF, bottomland hardwood forests, pine-mixed hardwood forests, xeric upland hardwood forests, cultivated fields, R; *1527, 1574, Bryson 2599, 2600, McDaniel 31066*, Theriot et al. (1993)

ASTERACEAE (COMPOSITAE)

**Achillea millefolium* L., BP, prairies, O; *McDaniel 13492*

Acmella oppositifolia (Lam.) R.K. Jansen var. *repens* (Walter) R.K. Jansen, PR, urban areas, RR; *McDaniel 12494*

Ambrosia artemisiifolia L., IF, bottomland hard wood forests, roadsides, C/A(I); *984, Brooks 483*, Theriot et al. (1993), *Wigley 314085*

Ambrosia bidentata Michx., IF, roadsides, C; *915*

Ambrosia psilostachya DC., BP, IF, pine forests, prairies, prairie cedar woodlands, chalk outcrops, C/A; *789*, Leidolf and McDaniel (1998), *McDaniel 15463, 22929*

Ambrosia trifida L., BP, prairies, urban areas, C/A; *993, Brooks 468, McDaniel 24964, Wigley 313093*

Amphiachyris dracunculoides (DC.) Nutt., BP, prairies, AA(I), **S1**; *McDaniel 22927*

Antennaria plantaginifolia (L.) Richardson, BP, IF, xeric upland hardwood forests, roadsides, O; *1262, 1535*

**Arctium minus* Bernh., BP, PR, cultivated fields, urban areas, O; *706, Bryson 3078*

Aster attenuatus Lindl. ex Hook., BP, prairies, O/C(I); *1015, MacDonald 8145*

Aster cordifolius L. var. *sagittifolius* (Wedem. ex Willd.) A.G. Jones, PR, bottomland hardwood forests, O; Morris et al. (1993)

Aster dumosus L., BP, PR, IF, bottomland hardwood forests, pine forests, prairies, C; *961, 991, Copeland s.n.*, Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993), *Wigley 314104*

Aster ericoides L., BP, prairies, C(I), **S2**; *1004, 1009a, 1011*, Leidolf and McDaniel (1998), *MacDonald 8142, 8152*

Aster laevis L., BP, prairies, O; *933*, Leidolf and McDaniel (1998)

Aster novae angliae L., BP, prairies, cultivated fields, roadsides, O/C; *1005, 1007, 1019, Gasparini 208*, Leidolf and McDaniel (1998), *McDaniel 1044*

Aster paludosus Aiton ssp. *hemisphericus* (Alexander) Cronquist, BP, IF, pine forests, prairies, seepage areas, roadsides, O/A(I); *650, 654, Brooks 410, Bryson 6986, Clonts 571, Copeland s.n.*

Aster patens Aiton, BP, IF, pine forests, prairies, chalk outcrops, O; *968*, Leidolf and McDaniel (1998), Morris et al. (1993)

Aster pilosus Willd. var. *pilosus*, BP, IF, prairies, cultivated fields, O; *990*, Leidolf and McDaniel (1998), *Gasparini 207, Wigley 313124*

Aster praealtus Poir. var. *praealtus*, BP, prairies, roadsides, O/C; *1009, 1012*, Leidolf and McDaniel (1998), *MacDonald 8149*

Aster sericeus Vent. var. *microphyllus* DC., BP, prairies, R/C(I); *1013*, Leidolf and McDaniel (1998), *MacDonald 8147*

Aster solidagineus Michx., IF, pine forests, pine mixed hardwood forests, seepage areas, roadsides, C(I); *349, 529, 1494, 1540, Bruza 929, Bryson 684, Clonts 831*

Aster subulatus Michx. var. *ligulatus* Shinners, PR, urban areas; *McDaniel 12528*

Aster undulatus L., BP, prairies, prairie cedar woodlands, roadsides, U/C(I); *1003, 1008, 1014*, Leidolf and McDaniel (1998), *MacDonald 8143, 8148, 8151*

Baccharis halimifolia L., BP, IF, bottomland hardwood forests, lakes/ponds/impoundments (riparian–banks), roadsides, C(I); *Clonts 472, McDaniel 31324, 31325*, Theriot et al. (1993), *Wigley 313120*

Bidens aristosa (Michx.) Britton, BP, IF, bottomland hardwood forests, pine forests, roadsides, O; *873, Brooks 482, Copeland s.n.*, Theriot et al. (1993), *Wigley 314083*

Bidens discoidea (Torr. & A. Gray) Britton, IF, bottomland hardwood forests, swamp forests; *Stewart 269*, Theriot et al. (1993)

Boltonia diffusa Elliott, IF, pine forests, roadsides, O; *664, Copeland s.n.*

Brickellia eupatorioides (L.) Shinners var. *eupatorioides*, BP, IF, chalk outcrops, C(I); *McDaniel 2193, 31310*

Brintonia discoidea (Elliott) Greene, IF, bottomland hardwood forests, pine forests, roadsides, O; *922*, Theriot et al. (1993)

Cacalia ovata Walter [= *Arnoglossum ovatum* (Walter) H. Rob.], IF, mesophytic upland hardwood forests, O; *902*

Cacalia plantaginea (Raf.) Shinners [= *Arnoglossum plantagineum* Raf.], BP, prairies, R/A; *375, 1445 (R375)*, Leidolf and McDaniel (1998), *McDaniel 13456, 31074*, Morris et al. (1993)

**Centaurea cyanus* L., PR, urban areas, RR; *McDaniel 13442*

Chrysopsis mariana (L.) Elliott, IF, mesophytic upland hardwood forests, roadsides, O/C; *954, Mathies 867*

**Cichorium intybus* L., BP, roadsides, RR; *680*

Cirsium discolor (Muhl. ex Willd.) Spreng., BP, prairies, chalk outcrops, lakes/ponds/impoundments (riparian–banks), O; *823, 832, Wigley 313092*

Cirsium horridulum Michx., BP, IF, prairies, prairie cedar woodlands, roadsides, O; *1438, 1455*, Leidolf and McDaniel (1998)

Coreopsis lanceolata L., BP, prairies, chalk outcrops, roadsides, C(I); *200, 268, 1451*, Leidolf and McDaniel (1998)

Coreopsis pubescens Elliott, BP, IF, pine forests, prairies, roadsides; *343, Brooks 122, 143, McDaniel 1089*

Coreopsis tinctoria Nutt., IF, roadsides, urban areas, C; *1573, Copeland s.n.*

Coreopsis tripteris L., IF, roadsides, C(I); *658, Brooks 494*

**Crepis pulchra* L., BP, urban areas, O; *1450*

Dracopis amplexicaulis (Vahl) Cass., BP, IF, prairies, roadsides, C; *289, 396, Copeland s.n.,* Leidolf and McDaniel (1998), *Sundell 1548*

Echinacea purpurea (L.) Moench, PR, xeric upland hardwood forests, **S3S4**; *Ray 4715* (MISSA)

Eclipta prostrata (L.) L., BP, IF, bottomland hardwood forests, pine forests, canals/drainage ditches (riparian–banks), lakes/ponds/impoundments (riparian–mudflats), seepage areas, cultivated fields, C/A; *609, Brooks 481, Bryson 3423, McDaniel 31333*, Theriot et al. (1993)

Elephantopus carolinianus Raeusch., IF, bottomland hardwood forests, pine forests, roadsides, O/A; *806, 877*, Lowe (1921), *Smith 945*, Theriot et al. (1993)

Elephantopus tomentosus L., IF, mesophytic upland hardwood forests, pine forests, pine-mixed hardwood forests, lakes/ponds/impoundments (riparian–banks), C; *1582, Brooks 488, Carraway 174, McDaniel 9797, 15726*

Erechtites hieracifolia (L.) Raf. ex DC., IF, bottomland hardwood forests; Theriot et al. (1993)

Erigeron annuus (L.) Pers., BP, PR, roadsides, O/A; *1503, Carter 3015*

Erigeron canadensis L. [= *Conyza canadensis* (L.) Cronquist var. *canadensis*], BP, PR, IF, prairies, roadsides, C; *551, 1597, McDaniel 31625, Wigley 313062*

Erigeron philadelphicus L., IF, seepage areas, O; *138*

Erigeron strigosus Muhl. ex Willd., BP, IF, bottomland hardwood forests, xeric upland hardwood forests, prairies, chalk outcrops, O; *203, 470, Bryson 716, Clonts 828*, Leidolf and McDaniel (1998)

Eupatorium altissimum L., BP, prairies, chalk outcrops, roadsides, O/A; *803*, Leidolf and McDaniel (1998), *McDaniel 20934, 22928, 28077, 31649*

Eupatorium capillifolium (Lam.) Small, IF, pine forests, urban areas; *Copeland s.n., Snow 39*

Eupatorium coelestinum L., BP, IF, bottomland hardwood forests, pine forests, chalk outcrops, lakes/ponds/impoundments (riparian–banks), roadsides, C/A(I); *528, 958, Bryson 706*, Lowe (1921), *McDaniel 31319, Wigley 313098*

Eupatorium hyssopifolium L., IF, pine forests, O; *700*

Eupatorium incarnatum Walter, BP, C; *McDaniel 31322*

Eupatorium perfoliatum L., IF, pine forests, O/C; *811, Brooks 475, Copeland s.n.*

Eupatorium rotundifolium L., IF, grass/forb meadows, roadsides, A; *471, Clonts 841, Mathies 841*

Eupatorium rugosum Houtt. [= *Ageratina altissima* (L.) King & H. Rob. var. *altissima*], BP, IF, bottomland hardwood forests, C; *972, McDaniel 31328*, Theriot et al. (1993)

Eupatorium scabridum Elliott [= *E. rotundifolium* L. var. *scabridum* (Elliott) Gray], IF, pine forests, roadsides, O; *655, Wigley 314088*

Eupatorium semiserratum DC., IF, mesophytic upland hardwood forests, pine forests, O; *555, Wigley 314087*

Eupatorium serotinum Michx., BP, IF, pine forests, chalk outcrops, seepage areas, C(I)/A; *683, Copeland s.n., McDaniel 22192, 22932*

Euthamia leptocephala (Torr. & A. Gray) Greene, IF, pine forests; *Wigley 314105*

Euthamia tenuifolia (Pursh) Nutt., PR, IF, pine forests, grass/forb meadows, O; *848, 875*

Evax prolifera Nutt. ex DC., BP, prairies, AA(I), **S1**; *195, 1442 (R195)*, Leidolf and McDaniel (1998)

**Facelis retusa* (Lam.) Sch. Bip., PR, IF, roadsides, urban areas, C(I); *1317, 1504*

Gnaphalium helleri Britton, IF, pine forests, O; *955*

Gnaphalium obtusifolium L., BP, IF, bottomland hardwood forests, pine forests, R/O; *McDaniel 1560, 31644*, Theriot et al. (1993)

Gnaphalium purpureum L. [= *Gamochaeta purpurea* (L.) Cabrera], PR, IF, pine-mixed hardwood forests, seepage areas, roadsides, urban areas, O/C; *180, 1290, McDaniel 15072, Wigley 313126*

Helenium amarum (Raf.) H. Rock, BP, IF, roadsides, A; *394, Wigley 312046*

Helenium autumnale L., BP, IF, bottomland hardwood forests, pine forests, prairie cedar woodlands, chalk outcrops, cultivated fields, O; *830, Copeland s.n., Gasparini 209*, Leidolf and McDaniel (1998), *McDaniel 1435, 15731, 31315*, Theriot et al. (1993)

Helenium flexuosum Raf., IF, mesophytic upland hardwood forests, O; *444, McDaniel 2540*

Helianthus angustifolius L., IF, roadsides, A(I); *872, Mathies 840*

Helianthus annuus L., BP, roadsides, A(I); *397*
Helianthus divaricatus L., BP, prairie cedar woodlands, O; *427*
Helianthus giganteus L., IF, roadsides, O; *881*
Helianthus hirsutus Raf., IF, pine forests, grass/forb meadows, O; *577, Clonts 840*
Helianthus mollis Lam., IF, pine forests, O; *589, 699*
Helianthus silphioides Nutt., IF, pine mixed hardwood forests, O; *808, Brooks 489, McDaniel 1433*
Helianthus strumosus L., BP, prairies, roadsides, O; *927*, Leidolf and McDaniel (1998), *McDaniel 15508*
Heliopsis gracilis Nutt., IF, mesophytic upland hardwood forests, O; *336*
Heterotheca camporum (Greene) Shinners, BP, prairies, chalk outcrops, C/A; *796, 841, 1596*, Leidolf and McDaniel (1998), *MacDonald 8146, McDaniel 22925*, Morris et al. (1993)
Hieracium gronovii L., IF, pine forests, urban areas, O/C(I); *648, McDaniel 2195, 2196*
Iva annua L., BP, IF, prairies, roadsides, A(I); *992, Copeland s.n., McDaniel 31630*
Krigia dandelion (L.) Nutt., PR, IF, roadsides, O; *175, Askew 48*
Krigia cespitosa (Raf.) K.L. Chambers, BP, PR, cultivated fields, roadsides, O; *179, Bryson 3499*
Lactuca canadensis L., BP, IF, xeric upland hardwood forests, prairies, lakes/ponds/impoundments (riparian–banks), roadsides, C; *Carraway 175, McDaniel 30273, Wigley 312049*
Lactuca floridana (L.) Gaertn., BP, IF, bottomland hardwood forests, prairie cedar woodlands, roadsides, O; *838*, Leidolf and McDaniel (1998), Theriot et al. (1993)
Lactuca hirsuta Muhl. ex Nutt., IF; *Bryson 677*
**Lactuca saligna* L., BP, PR, xeric upland hardwood forests, prairies, urban areas, O; *MacDonald 9897, McDaniel 30271*
**Lactuca serriola* L., PR, urban areas, O; *1598*
**Leucanthemum vulgare* Lam., BP, urban areas, C(I); *1447, 1463*
Liatris aspera Michx., BP, IF, prairies, roadsides, A; *516, 615 (R516), Copeland s.n.*, Leidolf and McDaniel (1998)
Liatris spicata (L.) Willd., BP, IF, pine forests, pine-mixed hardwood forests, prairies, R/U; *515, 563, Clonts s.n.*, Leidolf and McDaniel (1998), *McDaniel 2660*
Liatris squarrosa (L.) Michx., BP, prairies, chalk outcrops, R/A; *370, Clonts s.n.*, Leidolf and McDaniel (1998), *McDaniel 15505*, Morris et al. (1993)
Liatris squarrulosa Michx., BP, IF, prairies, chalk outcrops, roadsides, R/O; *969*, Leidolf and McDaniel (1998), *McDaniel 22924*
Mikania scandens (L.) Willd., BP, IF, bottomland hardwood forests, chalk outcrops, lakes/ponds/impoundments (riparian–banks), roadsides, C/A(I); *585, Brooks 479, McDaniel 22167*, Theriot et al. (1993), *Wigley 314084*
Pityopsis graminifolia (Michx.) Nutt., IF, seepage areas, C; *868*
Pluchea camphorata (L.) DC., BP, IF, bottomland hardwood forests, canals/drainage ditches (riparian–banks), lakes/ponds/impoundments (riparian–mudflats), seepage areas, C; *849*, Theriot et al. (1993), *Wigley 313100*
Prenanthes altissima L., PR, mesophytic upland hardwood forests, O; Morris et al. (1993)
Prenanthes aspera Michx., BP, prairies, O, **S2**; Leidolf and McDaniel (1998), *McDaniel 15622*
Pyrrhopappus carolinianus (Walter) DC., IF, pine forests, O; *574, 579, Bryson 726*
Pyrrhopappus pauciflorus (D. Don) DC., BP, prairies, roadsides, O; *McDaniel 31072, Sundell 1548*
**Ratibida columnifera* (Nutt.) Wooton & Standl., PR, urban areas, RR; *Smith s.n.*
Ratibida pinnata (Vent.) Barnhart, BP, prairies, prairie cedar woodlands, chalk outcrops, roadsides, O; *424, Copeland s.n.*, Leidolf and McDaniel (1998), *McDaniel 13445*, Morris et al. (1993)
Rudbeckia fulgida Aiton, BP, prairies, roadsides, O; *844*, Leidolf and McDaniel (1998)
Rudbeckia hirta L., BP, bottomland hardwood forests, xeric upland hardwood forests, prairies, O/A; *282, Bryson 723, Clonts 823*, Leidolf and McDaniel (1998), *McDaniel 31073, 31619*
Rudbeckia laciniata L., IF, bottomland hardwood forests; *Brooks 564*
Senecio anonymus Wood, BP, IF, pine forests, roadsides, urban areas, C; *255, 1441, 1449, McDaniel 13216, 29753, 31031*
Senecio glabellus Poir., PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, roadsides, C; *133, 1372, Smith 1932*, Theriot et al. (1993)
Senecio obovatus Muhl. ex Willd., BP, chalk out

crops, O; *McDaniel 31032*, *Morris 3097*, Morris et al. (1993)

Silphium integrifolium Michx., PR, roadsides, C; Leidolf pers. obs. (with *1001*)

Silphium laciniatum L., BP, chalk outcrops, grass/forb meadows, roadsides, C; *392*, *Clonts s.n.*, Leidolf and McDaniel (1998), Morris et al. (1993)

Silphium laciniatum L. × *S. terebinthinaceum* Jacq., BP, roadsides, RR; *852*

Silphium perfoliatum L., BP, IF, rivers/creeks (riparian–banks), roadsides, O; *625*, *687*, *McDaniel 25285*, *28877*

Silphium perfoliatum L. × *S. trifoliatum* L. var. *latifolium* A. Gray, BP, roadsides, RR; *837*

Silphium terebinthinaceum Jacq., BP, PR, bottomland hardwood forests, prairies, O; *843*, Leidolf and McDaniel (1998), Morris et al. (1993)

Silphium trifoliatum L. var. *latifolium* A. Gray, BP, prairies, chalk outcrops, C; *517*, *622*, *McDaniel 15502*

Solidago caesia L., IF, bottomland hardwood forests, mesophytic upland hardwood forests, O/C(l); *953*, Theriot et al. (1993)

Solidago canadensis L. var. *scabra* Torr. & A. Gray, BP, IF, pine forests, chalk outcrops, roadsides, O/C; *956*, *Copeland s.n.*, *McDaniel 28076*, *Wigley 313119*

Solidago gigantea Aiton, BP, IF, pine forests, prairies, chalk outcrops, O; *824*, *Brooks 316*, *McDaniel 31314*

Solidago hispida Muhl. ex Willd., IF, pine-mixed hardwood forests, C; *McDaniel 14665*

Solidago juncea Aiton, IF; *Wigley 312050*

Solidago nemoralis Aiton var. *haleana* Fernald, IF; *Bryson 6/8*

Solidago nemoralis Aiton var. *nemoralis*, BP, IF, bottomland hardwood forests, prairies, chalk outcrops, lakes/ponds/impoundments (riparian–banks), roadsides, O/C; *792*, *Carraway 176*, Leidolf and McDaniel (1998), Theriot et al. (1993)

Solidago odora Aiton var. *odora*, IF, pine forests, O/C; *962*, *Copeland s.n.*, *McDaniel 2192*

Solidago petiolaris Aiton, IF, pine forests, C; *McDaniel 15727*

Solidago rigida L., BP, prairies, C; *790*, Leidolf and McDaniel (1998)

Solidago rugosa Mill. ssp. *aspera* (Aiton) Cronquist, IF, pine-mixed hardwood forests, roadsides, O/C; *Copeland s.n.*, *Mathies 844*, *McDaniel 9795*, *14663*

Solidago ulmifolia Muhl. ex Willd., BP, IF, bottomland hardwood forests, pine forests, pine-mixed hardwood forests, prairies, O/C; *596*, *638*, Leidolf and McDaniel (1998), *McDaniel 31631*, Morris et al. (1993), Theriot et al. (1993)

**Soliva sessilis* Ruiz & Pav., PR, urban areas, O; *1214*

**Sonchus asper* (L.) Hill, BP, roadsides, O; *1339*, *1464*

**Sonchus oleraceus* L., BP, roadsides, O; *1459*

**Taraxacum officinale* Weber ex F.H. Wigg., BP, PR, bottomland hardwood forests, prairie cedar woodlands, roadsides, urban areas, O; *1268*, Leidolf and McDaniel (1998), Morris et al. (1993), *Wigley 313111*

Verbesina alternifolia (L.) Britton ex Kearney, IF, bottomland hardwood forests, roadsides, C; *973*, *1537*, *Brooks 563*, Theriot et al. (1993)

Verbesina helianthoides Michx., IF, pine forests, roadsides, C(l); *Brooks 277*, *Bruza 936*

Verbesina virginica L., BP, chalk outcrops, lakes/ponds/impoundments (riparian–banks), roadsides, O/A; *836*, *McDaniel 1491*, *31321*

Vernonia gigantea (Walter) Trel. ssp. *gigantea*, BP, PR, IF, bottomland hardwood forests, pine forests, grass/forb meadows, roadsides, O/C; *578*, *628*, *Bruza 1001*, *McDaniel 22930*, Morris et al. (1993)

**Xanthium strumarium* L., BP, IF, lakes/ponds/impoundments (riparian–banks), cultivated fields, grass/forb meadows, R/A(l); *819*, *Clonts 1404*, *McDaniel 31329*, *Wigley 313099*

**Youngia japonica* (L.) DC., BP, urban areas, O; *1520*

BALSAMINACEAE

Impatiens capensis Meerb.; Jones (1976b)

BERBERIDACEAE

*&*Mahonia bealei* (Fortune) Carrière, PR, mesophytic upland hardwood forests, R; *886*, *1307*

*&*Nandina domestica* Thunb., PR, mesophytic upland hardwood forests, R; *889*

Podophyllum peltatum L., PR, IF, mesophytic upland hardwood forests, AA(l); *88*, *99*, *1308*, *Askew 41*, Morris et al. (1993)

BETULACEAE

Betula nigra L., IF, bottomland hardwood forests, rivers/creeks (riparian–banks), lakes/ponds/impoundments (riparian–banks); *Anderson s.n.* (MISSA), *Hansbrough s.n.* (MISSA)

BIGNONIACEAE

Bignonia capreolata L., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, O/C; *134*, *Askew 60*, *McDaniel 2355*, Morris et al. (1993), Theriot et al. (1993)

Campsis radicans (L.) Seem. ex Bureau, BP, PR, IF, bottomland hardwood forests, pine-mixed hardwood forests, xeric upland hardwood forests, prairie cedar woodlands, C; *300*, *345*, Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

Catalpa bignonioides Walter, IF, rivers/creeks (riparian–banks), roadsides, O; *1492*, *Clonts 748*

BORAGINACEAE

**Buglossoides arvensis* (L.) I.M. Johnst., BP, roadsides, A(I); *144*

Cynoglossum virginianum L., PR, mesophytic upland hardwood forests, A(I); *1332*, Jones (1976b), Morris et al. (1993)

**Heliotropium indicum* L., IF, bottomland hardwood forests, pine forests, urban areas; *Clonts 1405*, *Copeland s.n.*, Jones (1976b), Theriot et al. (1993)

Heliotropium tenellum (Nutt.) Torr., BP, prairies, chalk outcrops, O/A; *368*, Jones (1976b), Leidolf and McDaniel (1998), *MacDonald 7529*, *McDaniel 15507*, *31088*, *31313*, Morris et al. (1993), Pullen et al. (1968b)

Lithospermum canescens (Michx.) Lehm., BP, prairies, chalk outcrops, grass/forb meadows, roadsides, O/C(I); *210*, *1269*, *Bryson 414*, Jones (1976b), Leidolf and McDaniel (1998), *McDaniel 31015*, *Morris 3096*, Morris et al. (1993)

Lithospermum latifolium Michx., PR, mesophytic upland hardwood forests; *Gordon 2064*

Lithospermum tuberosum Rugel ex DC., PR, mesophytic upland hardwood forests, O/C; *1331*, Jones (1976b), *Smith 1933*

Myosotis macrosperma Engelm., PR, mesophytic upland hardwood forests, O; *1334*, *1352*, Jones (1976b)

Myosotis verna Nutt., BP, cultivated fields; *Bryson 3484*, Jones (1976b)

Onosmodium molle Michx. ssp. *hispidissimum* (Mack.) B. Boivin, BP, prairies, O; *1603*, Jones (1976b), *McDaniel 31064*, Morris et al. (1993)

BRASSICACEAE (CRUCIFERAE)

**Arabidopsis thaliana* (L.) Heynh.; Jones (1975a)

Armoracia lacustris (A. Gray) Al-Shehbaz & Bates, BP, grass/forb meadows, O, **S1S2**; *McDaniel 25025*

**Brassica erucastrum* L. [= *Erucastrum gallicum* (Willd.) O.E. Schulz], BP, chalk outcrops, O/C; *78*, *465*, *1461*, *McDaniel 24994*, *Smith 1448*

**Brassica juncea* (L.) Czern., PR, urban areas, RR; *1325*

**Brassica napus* L., PR, roadsides, RR; *1260*

**Capsella bursa-pastoris* (L.) Medik., BP, PR, cultivated fields, roadsides, urban areas, C; *63*, *Bryson 3488*, *Stewart 128*

Cardamine bulbosa (Schreb. ex Muhl.) Britton, Sterns & Poggenb., PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, grass/forb meadows, O; *90*, *1333*, *1377*, *Askew 45*, Jones (1975a)

Cardamine concatenata (Michx.) Sw., PR, mesophytic upland hardwood forests, O; *151*, *Morris 3091*, Morris et al. (1993)

**Cardamine hirsuta* L., PR, urban areas, A; *23*, *1209*, Jones (1975a), *Stewart 145*

Cardamine parviflora L.; Jones (1975a)

**Coronopus didymus* (L.) Small, PR, IF, pine forests, urban areas, O; *1205*, *Copeland and Warren s.n.*

Draba brachycarpa Nutt. ex Torr. & A. Gray, BP, prairies, urban areas, A; *1266*

Draba cuneifolia Nutt. ex Torr. & A. Gray, BP, prairies, C(I); *McDaniel 10415*

**Lepidium perfoliatum* L., BP, urban areas, RR; *Ray s.n.* (MISSA)

Lepidium virginicum L., BP, prairies, cultivated fields, roadsides, A; *199*, *395*, *1287*

**Raphanus raphanistrum* L., PR, roadsides, O; *76*

Rorippa sessiliflora (Nutt.) Hitchc., BP, PR, canals/drainage ditches (riparian–banks), cultivated fields, grass/forb meadows, urban areas, R/C; *1305*, *Bryson 7420*, *McDaniel 24753*, *25027*

Sibara virginica (L.) Rollins, BP, cultivated fields, roadsides, A; *1272*, *1279*, *Bryson 3490*, Jones (1975a)

**Sisymbrium officinale* (L.) Scop.; Jones (1975a)

**Thlaspi perfoliatum* L., BP, roadsides, C; *McDaniel 33025*

BUDDLEJACACEAE

Polypremum procumbens L., BP, IF, xeric upland hardwood forests, canals/drainage ditches (riparian–banks), seepage areas, cultivated fields, roadsides, urban areas, C(I); *441*, *1570*, *Bryson 2612*, *McDaniel 1503*

CABOMBACEAE

Brasenia schreberi J.F. Gmel., IF, lakes/ponds/impoundments (littoral–rooted-floating), A(I) *580, 657*

CACTACEAE

Opuntia humifusa (Raf.) Raf., BP, PR, grass/forb meadows, roadsides, R; *813, 940*

CALLITRICHACEAE

Callitriche heterophylla Pursh, IF, canals/drainage ditches (submergent), lakes/ponds/impoundments (littoral–submergent), seepage areas, C(I); *126, McDaniel 10491*

CAMPANULACEAE

Campanula americana L. [= *Campanulastrum americanum* (L.) Small], BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, prairie cedar woodlands, roadsides, O/C(I); *624, 822, 1604, MacDonald 9720, McDaniel 28888, 31640*, Morris et al. (1993), *Smith 1411*

Lobelia appendiculata A. DC., IF, pine-mixed hardwood forests, roadsides, A(I), **S2S3**; *322, 342, 363, 364*

Lobelia cardinalis L., IF, bottomland hardwood forests, mesophytic upland hardwood forests, rivers/creeks (riparian–mudflats), lakes/ponds/impoundments (riparian–mudflats), R/C; *812, 944, 980, Bruza 1332*, Theriot et al. (1993)

Lobelia puberula Michx., BP, IF, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, pine forests, pine-mixed hardwood forests, seepage areas, roadsides, O; *524a, 809, 957, Clonts 572, McDaniel 31621*, Theriot et al. (1993)

Lobelia spicata Lam., BP, prairies, O; *295*, Leidolf and McDaniel (1998), *McDaniel 15511*, Morris et al. (1993)

Specularia biflora (Ruiz & Pav.) Fisch. & C.A. Mey. [= *Triodanis perfoliata* (L.) Nieuwl. var. *biflora* (Ruiz & Pav.) Bradley], IF, bottomland hardwood forests, O; *230*

Specularia perfoliata (L.) A. DC. [= *Triodanis perfoliata* (L.) Nieuwl. var. *perfoliata*], BP, prairies, roadsides, O; *1361, 1454, 1465, Brooks 155*, Lowe (1921), *McDaniel 31013*

CANNABACEAE

**Cannabis sativa* L., IF, roadsides, RR; *807*

CAPRIFOLIACEAE

**Lonicera japonica* Thunb., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, prairie cedar woodlands, pine forests, pine-mixed hardwood forests, rivers/creeks (riparian–banks), roadsides, C; *215, Brooks 129*, Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

Lonicera sempervirens L., PR, xeric upland hardwood forests, R; *1366*

Sambucus canadensis L., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, canals/drainage ditches (riparian–banks), C; *309*, Morris et al. (1993), Theriot et al. (1993)

Symphoricarpos orbiculatus Moench, BP, PR, mesophytic upland hardwood forests, xeric upland hardwood forests, roadsides, O/C; *799, McDaniel 1501, 31650*, Morris et al. (1993)

Triosteum angustifolium L., PR, mesophytic upland hardwood forests, R/C, **S3**; *Channell s.n.* (MISSA), *Funchess s.n.* (MISSA), *Hull s.n.* (MISSA), *Rainwater s.n.* (MISSA), *Ray 931* (MISSA), *Smith 1934*

Viburnum rufidulum Raf., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, prairie cedar woodlands, O; *114, 150, 160*, Leidolf and McDaniel (1998), Morris et al. (1993)

CARYOPHYLLACEAE

**Arenaria serpyllifolia* L., BP, roadsides, A(I); *McDaniel 29754*

**Cerastium brachypetalum* Desportes, BP, roadsides, C; *71a*

**Cerastium glomeratum* Thuill., BP, PR, cultivated fields, roadsides, urban areas, C/A; *71, 1211, Bryson 3486*

Sagina decumbens (Elliott) Torr. & A. Gray, BP, PR, xeric upland hardwood forests, urban areas, C/A; *1277, 1357*

Silene antirrhina L., BP, IF, grass/forb meadows, roadsides, O/A; *1485, Bryson 8862*, Pullen et al. (1968b)

Silene stellata (L.) W.T. Aiton, PR, IF, mesophytic upland hardwood forests, O; *885, McDaniel 28885*, Morris et al. (1993)

**Spergula arvense* L., BP, cultivated fields, A; *1286*

**Stellaria media* (L.) Vill., PR, urban areas, A; *10, 1212*

CELASTRACEAE

Evonymus americanus L., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, rivers/creeks (riparian–banks), roadsides, O; *259*, *945*, *Bryson 728*, Morris et al. (1993), Theriot et al. (1993)

Evonymus atropurpureus Jacq., PR, mesophytic upland hardwood forests, RR, **S2S3**; *Morris 3086*, Morris et al. (1993)

**Evonymus fortunei* (Turcz.) Hand. -Mazz., PR, urban areas, RR; *MacDonald 9994*

CISTACEAE

Lechea mucronata Raf., IF, grass/forb meadows, O; *1586*

Lechea tenuifolia Michx., IF, pine forests, seepage areas, roadsides, C(I); *485*, *573*, *1534*, *McDaniel 13489*

CONVOLVULACEAE

Cuscuta compacta Juss. ex Choisy; *Anonymous s.n.* (MISSA)

Cuscuta pentagona Engelm. var. *pentagona*, BP, IF, prairies, grass/forb meadows, A(I); *428*, *942*

**Ipomoea hederacea* Jacq., BP, cultivated fields, C/A; *821*, *Bryson 2598*

Ipomoea lacunosa L., BP, cultivated fields, C/A; *820*, *Bryson 2597*

Ipomoea pandurata (L.) G. Mey., BP, cultivated fields, A; *519*

**Ipomoea wrightii* A. Gray, IF, cultivated fields, A(I); *711*

Jacquemontia tamnifolia (L.) Griseb., IF, lakes/ponds/impoundments (riparian–mudflats), grass/forb meadows, roadsides, O; *598*, *Clonts 1407*

CORNACEAE

Cornus drummondii C.A. Mey., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, prairie cedar woodlands, chalk outcrops, roadsides, O; *274*, *620*, *Bryson 8294*, *Carter 3005*, Leidolf and McDaniel (1998), *McDaniel 31068*, Morris et al. (1993)

Cornus florida L., PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, pine-mixed hardwood forests, C; *124*, *351*, *964*, *Askew 39*, Morris et al. (1993), Theriot et al. (1993)

Cornus stricta Lam. [– *C. foemina* Mill.], IF, bottomland hardwood forests, O; *244*, *McDaniel 1562*, Theriot et al. (1993)

Nyssa sylvatica Marshall, IF, bottomland hardwood forests, pine forests, pine-mixed hardwood forests, C; *1482*, *Smith 2540*, Theriot et al. (1993)

CORYLACEAE

Carpinus caroliniana Walter, IF, bottomland hardwood forests, C; *234*

Ostrya virginiana (Mill.) K. Koch, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, O; *Leidolf s.n.*, Morris et al. (1993)

CRASSULACEAE

Sedum pulchellum Michx., BP, PR, chalk outcrops, R, **S1**; *Brent 181*, *Stauffer s.n.* (MISSA)

CUCURBITACEAE

Cayaponia quinqueloba (Raf.) Shinners; Jones (1976b), Pullen et al. (1968b)

Melothria pendula L., BP, PR, IF, lakes/ponds/impoundments (riparian–banks), roadsides, C; *705*, *724*, Jones (1976b), *McDaniel 31327*

DROSERACEAE

Drosera brevifolia Pursh, IF, seepage areas, R; *1289*, *1437 (R1289)*

EBENACEAE

Diospyros virginiana L., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, pine-mixed hard wood forests, prairie cedar woodlands, chalk outcrops, O; *1462*, Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

ELAEAGNACEAE

**Elaeagnus pungens* Thunb., PR, mesophytic upland hardwood forests, O; *888*

**Elaeagnus umbellata* Thunb., PR, urban areas, RR; *1324*

ERICACEAE

Monotropa hypopithys L., PR, mesophytic upland hardwood forests, R; Morris et al. (1993)

Monotropa uniflora L., IF; *Stewart 116*

Rhododendron canescens (Michx.) Sweet, IF, bottomland hardwood forests, mesophytic upland hardwood forests, O/C; *125*, *130*, *Askew 40*, *Leidolf s.n.*, Theriot et al. (1993)

Vaccinium arboreum Marshall, BP, IF, bottomland

hardwood forests, swamp forests, xeric upland hardwood forests, pine forests, O; *1359, 1550, Brooks 132, Carter 3020, Clonts 830, McDaniel 1091*, Theriot et al. (1993)

Vaccinium elliottii Chapm., IF, bottomland hard wood forests, pine-mixed hardwood forests, O; *36*, Theriot et al. (1993)

Vaccinium elliottii Chapm. × *V. fuscatum* Aiton, IF, bottomland hardwood forests, RR; Theriot et al. (1993)

Vaccinium stamineum L., PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, pine-mixed hardwood forests, R/C; *593, 665, 1291, 1351(R665), 1381, Brooks 120*, Theriot et al. (1993)

Vaccinium virgatum Aiton, IF, bottomland hardwood forests; *McDaniel 3000*

ESCALLONIACEAE

Itea virginica L., IF, bottomland hardwood forests, swamp forests, lakes/ponds/impoundments (riparian–banks), O; *265, McDaniel 1828*

EUPHORBIACEAE

Acalypha gracilens A. Gray, IF, seepage areas, O; *649*

Acalypha ostryifolia Riddell, BP, IF, prairies, cultivated fields, roadsides, C; *794, 1544, Gasparini 203*, Pullen et al. (1968b)

Acalypha rhomboidea Raf. [= *A. virginica* L. var. *rhomboidea* (Raf.) Cooperr.], IF, rivers/creeks (riparian–banks), roadsides, O; *686*

Acalypha virginica L., BP, IF, chalk outcrops, lakes/ponds/impoundments (riparian–banks), roadsides, O; *600, 630, Brooks 485, McDaniel 22197*, Pullen et al. (1968b)

Chamaesyce humistrata (Engelm.) Small, BP, chalk outcrops, C; *McDaniel 22201*

Chamaesyce maculata (L.) Small, BP, PR, IF, chalk outcrops, rivers/creeks (riparian–banks), cultivated fields, roadsides, urban areas, C; *423, 544, 690, McDaniel 2202, 22199*

Chamaesyce nutans (Lag.) Small, BP, IF, rivers/creeks (riparian–banks), canals/drainage ditches (riparian–banks), cultivated fields, O/A; *504, Brooks 469, Bryson 3443, MacDonald 7, McDaniel 31627*

Chamaesyce prostrata (Aiton) Small, BP, PR, cultivated fields, urban areas, C; *Bryson 3445, McDaniel 2203, Stewart 151*

Chamaesyce serpens (Kunth) Small, BP, chalk outcrops, C; *McDaniel 22198*

Croton capitatus Michx., BP, IF, pine-mixed hardwood forests, prairies, roadsides, C; *379, 565, Brooks 323*

Croton glandulosus L. var. *septentrionalis* Müll. Arg., IF, pine-mixed hardwood forests, roadsides, C(I); *538, Brooks 319*

Croton monanthogynus Michx., BP, prairies, chalk outcrops, cultivated fields, C/A(I); *367, Bryson 8315*, Leidolf and McDaniel (1998), *McDaniel 1492, 24447, 31317, 31629*, Morris et al. (1993), Pullen et al. (1968b)

Euphorbia commutata Engelm., PR, mesophytic upland hardwood forests, O; Morris et al. (1993)

Euphorbia corollata L., BP, IF, xeric upland hardwood forests, pine forests, prairies, chalk outcrops, roadsides, C; *281, 641, Brooks 144, 318, Bryson 8296*, Leidolf and McDaniel (1998), *McDaniel 15622a*, Morris et al. (1993)

Euphorbia dentata Michx., IF, rivers/creeks (riparian–banks), O; *684*, Pullen et al. (1968b)

Euphorbia heterophylla L., BP, prairies, A; *McDaniel 15620*

Euphorbia spathulata Lam., BP, IF, prairies, prairie cedar woodlands, grass/forb meadows, O; *1346, 1511, Morris 3081*, Morris et al. (1993)

Tragia cordata Michx., BP, PR, IF, xeric upland hardwood forests, R; *1528, McDaniel 28890*

Tragia urticifolia Michx., BP, prairies, O; *1519, McDaniel 31632*, Morris et al. (1993), Pullen et al. (1968b)

FABACEAE (LEGUMINOSAE)

**Albizia julibrissin* Durazz., PR, roadsides, C; *462*

Amorpha fruticosa L., BP, IF, bottomland hardwood forests, xeric upland hardwood forests, roadsides, O; *271, 643, McDaniel 31026*, Theriot et al. (1993)

Amphicarpaea bracteata (L.) Fernald, IF, mesophytic upland hardwood forests, O; *904*

Apios americana Medik., BP, PR, prairie cedar woodlands, rivers/creeks (riparian–banks), canals/drainage ditches (riparian–banks), O/A(I); *677, 1606, McDaniel 28926*

Apios priceana B.L. Rob., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, C(I), **FT**, **S1**; *Gordon 2050, 2051, Morris 3100*, Morris et al. (1993)

Astragalus canadensis L. var. *canadensis*, BP, U;, **S2**; *Gordon 2048*

Baptisia alba (L.) R. Br. var. *macrophylla* (Larisey) Isley, IF, lakes/ponds/impoundments (riparian–banks), roadsides, O; *1471, 1568*

Centrosema virginianum (L.) Benth., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, rivers/creeks (riparian–banks), roadsides, O; *533, 674, Bruza 1007, McDaniel 28883*

Cercis canadensis L., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, prairies, prairie cedar woodlands, rivers/creeks (riparian–banks), C; *64, 74, 201*, Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

Chamaecrista fasciculata (Michx.) Greene, BP, IF, pine forests, prairies, urban areas, C; *365, Brooks 315*, Leidolf and McDaniel (1998)

Chamaecrista nictitans (L.) Moench, IF, pine forests, O; *Brooks 408*

Clitoria mariana L., IF, pine forests, lakes/ponds/impoundments (riparian–banks), O; *637, Brooks 317, Copeland s.n.*

**Coronilla varia* L., BP, roadsides; *Brooks 210, Mac Donald 10888*

Crotalaria sagittalis L., BP, IF, prairies, seepage areas, O; *297, 701*, Leidolf and McDaniel (1998)

Dalea candida Willd., BP, prairies, chalk outcrops, C/A; *284, Bruza 938*, Leidolf and McDaniel (1998), *McDaniel 13457, 31094*, Morris et al. (1993)

Dalea purpurea Vent., BP, prairies, chalk outcrops, R/A; *283, Bruza 939*, Leidolf and McDaniel (1998), *McDaniel 13459, 31095, 31101*, Morris et al. (1993)

Desmanthus illinoensis (Michx.) MacMill. ex B.L. Rob. & Fernald, BP, IF, xeric upland hardwood forests, prairies, canals/drainage ditches (riparian–banks), roadsides, O; *398, 642, Clonts s.n.*, Leidolf and McDaniel (1998), *Wigley 315064*

Desmodium canescens (L.) DC., BP, IF, bottomland hardwood forests, rivers/creeks (riparian–banks), O; *678*, Theriot et al. (1993)

Desmodium ciliare (Muhl. ex Willd.) DC., BP, xeric upland hardwood forests, prairies, chalk outcrops, O/C; *793*, Leidolf and McDaniel (1998), *McDaniel 1502, 15504, Wigley 315067*

Desmodium cuspidatum (Muhl. ex Willd.) DC. ex Loudon, PR, bottomland hardwood forests, O; Morris et al. (1993)

Desmodium glabellum (Michx.) DC., IF, seepage areas, roadsides, O; *986*

Desmodium glutinosum (Muhl. ex Willd.) Alph. Wood, PR, IF, mesophytic upland hardwood forests, O/C; *560, McDaniel 28884*

Desmodium laevigatum (Nutt.) DC., IF, pine forests; *Brooks 473*

Desmodium nudiflorum (L.) DC., PR, IF, mesophytic upland hardwood forests, C; *559*, Morris et al. (1993)

Desmodium paniculatum (L.) DC., IF, pine forests, roadsides, O; *858, Wigley 314113*

Desmodium pauciflorum (Nutt.) DC., PR, mesophytic upland hardwood forests, O; Morris et al. (1993)

Desmodium perplexum B.G. Schub., BP, PR, mesophytic upland hardwood forests, rivers/creeks (riparian -banks), canals/drainage ditches (riparian–banks), O; *670, 834*

Desmodium rotundifolium DC., IF, mesophytic upland hardwood forests, C(I); *907, 1581(R907)*

Dioclea multiflora (Torr. & A. Gray) C. Mohr, IF, bottomland hardwood forests, mesophytic upland hardwood forests, O; *331, 557(R331), Bryson 721, Clonts 473*, Theriot et al. (1993)

Galactia volubilis (L.) Britton, BP, IF, prairies, seepage areas, O; *518, 532, Bruza 924*

Gleditsia triacanthos L., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, roadsides, O; *Leidolf s.n.*, Morris et al. (1993), Theriot et al. (1993)

**Kummerowia striata* (Thunb.) Schindl., IF, pine forests, roadsides, A; *545, Brooks 409, Wigley 314023*

**Lathyrus hirsutus* L., BP, IF, prairies, lakes/ponds/impoundments (riparian–banks), canals/drainage ditches (riparian–banks), roadsides, O; *316, 1470, Brooks 152*, Pullen et al. (1968b), *Sundell 1549*

**Lespedeza bicolor* Turcz., IF, mesophytic upland hardwood forests, O; *443*

Lespedeza capitata Michx., IF, pine forests, seepage areas, roadsides, U; *867, 921*

**Lespedeza cuneata* (Dum. Cours.) G. Don, BP, IF, pine forests, prairies, prairie cedar woodlands, rivers/creeks (riparian–banks), road-

sides, C; *569, 676*, Leidolf and McDaniel (1998), *McDaniel 15509*

Lespedeza procumbens Michx., BP, chalk outcrops, C(I); *McDaniel 31316, 31648*

Lespedeza repens (L.) Barton, IF, pine forests, roadsides, O; *570, Brooks 496*, Lowe (1921)

Lespedeza violacea (L.) Pers., IF, pine forests; *Copeland s.n.*, Lowe (1921)

Lespedeza virginica (L.) Britton, BP, IF, xeric upland hardwood forests, pine forests, O; *702, Brooks 399, McDaniel 31624, Wigley 314086*

**Medicago arabica* (L.) Huds., BP, PR, cultivated fields, urban areas, U; *1206, 1288*, Lowe (1921)

**Medicago lupulina* L., BP, PR, prairies, roadsides, C; *75, McDaniel 31091*, Pullen et al. (1968b)

**Melilotus alba* Medik., BP, prairies, chalk outcrops, roadsides, C/A; *287, Brooks 142*, Leidolf and McDaniel (1998), *McDaniel 13451, 31096*, Morris et al. (1993)

**Melilotus officinalis* (L.) Lam. [= *Melilotus albus* Medik.], BP, roadsides, C; *292*

Neptunia lutea (Leavenw.) Benth., BP, prairies, prairie cedar woodlands, O/A(I), **S3S4**; *299, 399, 426, 466, Channell 73* (MISSA), *Davis s.n.* (MISSA), Leidolf and McDaniel (1998), *McDaniel 13460*, Morris et al. (1993), *Smith 1412*

Psoralea psoralioides (Walter) Cory [= *Orbexilum pedunculatum* (Mill.) Rydb. var. *psoralioides* (Walt.) Isely], BP, IF, pine forests, seepage areas, roadsides, U/C; *272, 1439, McDaniel 3147*

Rhynchosia tomentosa (L.) Hook. & Arn., BP, IF, prairies, grass/forb meadows, urban areas, O; *1589, 1600, McDaniel 31634*

Robinia pseudoacacia L., PR, roadsides, urban areas, O; *1321*

Schrankia microphylla (Dryand.) J.F. Macbr. [= *Mimosa quadrivalvis* L. var. *angustata* (Torr. & A. Gray) Barneby], IF, pine forests, pine-mixed hardwood forests, roadsides, O/C; *330, Bruza 928, McDaniel 13488*

Senna marilandica (L.) Link, IF, bottomland hardwood forests; Theriot et al. (1993)

**Senna obtusifolia* (L.) Irwin & Barneby, IF, lakes/ponds/impoundments (riparian–banks), C; *604*

Sesbania exaltata (Raf.) Rydb. ex A.W. Hill, BP, IF, rivers/creeks (riparian–banks), seepage areas, roadsides, C(I); *104, McDaniel 25286*

Strophostyles helvula (L.) Elliott, IF, pine forests, O; *595*

Strophostyles umbellata (Muhl. ex Willd.) Britton, IF, pine forests, O/C; *698, Brooks 495, Copeland s.n., McDaniel 2191*

Stylosanthes biflora (L.) Britton, Sterns & Poggenb., IF, mesophytic upland hardwood forests, O; *339, Wigley 312048*

Tephrosia spicata (Walter) Torr. & A. Gray, IF, pine-mixed hardwood forests, roadsides, C(I); *319, 1567, Clonts 820*

Tephrosia virginiana (L.) Pers., IF, pine forests, pine-mixed hardwood forests, O; *346, 531, Brooks 279*

**Trifolium arvense* L., BP, grass/forb meadows; *O'Brein s.n.* (MISSA), *Locke s.n.* (MISSA)

**Trifolium campestre* Schreb., PR, IF, roadsides, urban areas, C; *1311, 1315, 1323*

**Trifolium dubium* Sibth., BP, PR, prairie cedar woodlands, O; *223*, Pullen et al. (1968b)

**Trifolium incarnatum* L., PR, roadsides, A(I); *100*, Pullen et al. (1968b)

**Trifolium lappaceum* L., BP, PR, prairies, roadsides, urban areas, C; *1514, 1533a, Brooks 145, MacDonald 8721*, Morris et al. (1993)

**Trifolium pratense* L., BP, prairies, grass/forb meadows, roadsides, C(I); *164, Brooks 147, Sundell 1544, Wigley 313011*

Trifolium reflexum L., IF, pine forests, C(I); *McDaniel 21235*

**Trifolium repens* L., BP, PR, IF, roadsides, urban areas, C; *405, Askew 37, Wigley 314080*

**Trifolium resupinatum* L., BP, prairies, roadsides, O; *145, Brooks 153*, Pullen et al. (1968b)

Vicia caroliniana Walter, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, O; *248, 1296 (R248)*, Morris et al. (1993)

**Vicia grandiflora* Scop., BP, IF, cultivated fields, roadsides, O; *139, 1283*, Pullen et al. (1968b)

Vicia minutiflora F. Dietr., PR, xeric upland hardwood forests, O; *Ray 8006* (MISSA)

**Vicia sativa* L. ssp. *nigra* (L.) Ehrh., IF, roadsides, O; *137*, Pullen et al. (1968b)

**Vicia tetrasperma* (L.) Schreb., PR, canals/drainage ditches (riparian–banks); *Fletcher s.n.* (MISSA)

**Vicia villosa* Roth ssp. *varia* (Host) Corb., BP, PR, roadsides, O; *178, Brooks 209*, Pullen et al. (1968b)

Wisteria frutescens (L.) Poir., IF, lakes/ponds/impoundments (riparian–banks), R; *636*

**Wisteria sinensis* (Sims) DC., IF, roadsides, urban areas, O/C; *91, Askew 38 (R Leidolf 91)*

FAGACEAE

Fagus grandifolia Ehrh., BP, IF, bottomland hardwood forests, mesophytic upland hardwood forests, C; *475, 952, 1583 (R952), Laird 6*, Theriot et al. (1993)

Quercus alba L., PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, pine forests, C; *306, 1554*, Theriot et al. (1993)

Quercus durandii Buckley [– *Q. sinuata* Walter var. *sinuata*], BP, bottomland hardwood forests; *McDaniel 1067*

Quercus falcata Michx., IF, bottomland hardwood forests, xeric upland hardwood forests, pine forests, pine mixed hardwood forests, C; *1551*, Theriot et al. (1993)

Quercus laurifolia Michx., IF, bottomland hardwood forests, O; Leidolf pers. obs., Theriot et al. (1993)

Quercus lyrata Walter, IF, bottomland hardwood forests, swamp forests, rivers/creeks (riparian–banks), C; *355, Leidolf s.n.*, Theriot et al. (1993)

Quercus macrocarpa Michx., BP, xeric upland hardwood forests, R, **S2**; *1526a, Bryson 3123, McDaniel 32330, Smith 364*

Quercus marilandica Muenchh., BP, IF, xeric upland hardwood forests, prairie cedar woodlands, C; *387, 1553*, Leidolf and McDaniel (1998), Morris et al. (1993)

Quercus michauxii Nutt., IF, bottomland hardwood forests, C; *Leidolf s.n.*, Theriot et al. (1993)

Quercus muehlenbergii Engelm., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, prairie cedar woodlands, O; *435, Bryson 3124, 7440*, Leidolf and McDaniel (1998), *McDaniel 28151, 31646*, Morris et al. (1993)

Quercus nigra L., BP, IF, bottomland hardwood forests, xeric upland hardwood forests, pine forests, pine-mixed hardwood forests, O; *Leidolf s.n., McDaniel 31612a*, Theriot et al. (1993)

Quercus pagoda Raf., BP, IF, bottomland hardwood forests, xeric upland hardwood forests, O; *1458, Leidolf s.n., McDaniel 31613*, Theriot et al. (1993)

Quercus phellos L., BP, IF, bottomland hardwood forests, pine forests, prairie cedar woodlands, lakes/ponds/impoundments (riparian–banks), C; *982, 1592, Leidolf s.n.*, Leidolf and McDaniel (1998), Theriot et al. (1993)

Quercus rubra L., BP, IF, bottomland hardwood forests, O; *Laird 29, Leidolf s.n.*, Theriot et al. (1993)

Quercus shumardii Buckley, BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, pine forests, C; *354, 1555, Bryson 3126, Leidolf s.n., McDaniel s.n.*, Morris et al. (1993), Theriot et al. (1993)

Quercus stellata Wangenh., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine-mixed hardwood forests, prairie cedar woodlands, C; *305*, Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

Quercus texana Buckley, IF, bottomland hardwood forests, O; *Leidolf s.n.*, Theriot et al. (1993)

Quercus velutina Lam., BP, PR, mesophytic upland hardwood forests, xeric upland hardwood forests, R; *307, McDaniel 31614*

GENTIANACEAE

Frasera caroliniensis Walter, PR, mesophytic upland hardwood forests, U/A(I), **S2S3**; *Morris 3099*, Morris et al. (1993), *Ray 6724*

Sabatia angularis (L.) Pursh, BP, prairies, prairie cedar woodlands, chalk outcrops, O; *372*, Morris et al. (1993)

Sabatia brachiata Elliott, IF, pine-mixed hardwood forests, roadsides, O/C; *347, 1539, McDaniel 2534*

GERANIACEAE

Geranium carolinianum L., BP, lakes/ponds/impoundments (riparian–banks), roadsides, C; *189, McDaniel 31050*

**Geranium dissectum* L., BP, roadsides, C; *157*

Geranium maculatum L., PR, mesophytic upland hardwood forests, O; *Smith 1931*

HALORAGACEAE

**Myriophyllum aquaticum* (Vell.) Verdc.; Jones (1975b)

HAMAMELIDACEAE

Hamamelis virginiana L., IF, bottomland hardwood forests, O; *975*, Theriot et al. (1993)

Liquidambar styraciflua L., BP, PR, IF, bottomland hardwood forests, pine forests, pine mixed hardwood forests, xeric upland hardwood forests, C; *333*, Bryson (1980), *McDaniel 31615*, Morris et al. (1993), Theriot et al. (1993)

HIPPOCASTANACEAE

Aesculus × *bushii* Schneid. [= *A. pavia* L. × *A. glabra* Willd.], BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, rivers/creeks (riparian–banks), O/C; *109*, *112*, *Bennett 2 (UTC)*, *3 (UTC)*, *4 (UTC)*, *5 (UTC)*, *6 (UTC)*, *7 (UTC)*, Morris et al. (1993)

Aesculus glabra Willd., BP, PR, bottomland hardwood forests, rivers/creeks (riparian banks), C(I), **S2?**; *72*, *108*, *111*, *128*, *438*, *1270*, *Askew 32*, *Carpenter s.n.* (MISSA), *Channell s.n.* (MISSA), *Funchess s.n.* (MISSA), *Graham s.n.* (MISSA), Lowe (1921), *McDaniel 1066*, *Morris 3084*, Morris et al. (1993), *Persons s.n.* (MISSA), *Read s.n.* (MISSA), *Smith 1895*, *Tracy s.n.* (MISSA), *Webb 80* (MISSA)

Aesculus pavia L., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, rivers/creeks (riparian–banks), C; *65*, *110*, *119*, *McDaniel 1069*, *31027a*, Morris et al. (1993), Theriot et al. (1993)

HYDRANGEACEAE

Hydrangea quercifolia W. Bartram, IF, bottomland hardwood forests, pine-mixed hardwood forests, R; *1498*, *Bryson 732*, *Laird 16*

HYDROPHYLLACEAE

Hydrolea uniflora Raf., IF, rivers/creeks (emergent), lakes/ponds/impoundments (littoral emergent), A(I); *576*, *725*, Jones (1975b), *McDaniel 20935*

HYPERICACEAE (GUTTIFERAE)

Hypericum crux-andreae (L.) Crantz, IF, pine-mixed hardwood forests, seepage areas, O/C; *647*, *Brooks 403*, *McDaniel 2659*

Hypericum drummondii (Grev. & Hook.) Torr. & A. Gray, IF, roadsides, O/C; *719*, *McDaniel 1568*, *2028*

Hypericum gentianoides (L.) Britton, Sterns & Poggenb., IF, seepage areas, roadsides, A(I); *645*, *Bryson 129*

Hypericum gymnanthum Engelm. & A. Gray, IF, canals/drainage ditches (riparian–banks), O; *503*

Hypericum hypericoides (L.) Crantz, IF, bottomland hardwood forests, pine forests, pine-mixed hardwood forests, seepage areas, C; *874*, *1481*, *Brooks 404*, Theriot et al. (1993)

Hypericum lobocarpum Gatt., IF, rivers/creeks (riparian–banks), canals/drainage ditches (riparian banks), lakes/ponds/impoundments (riparian–banks), seepage areas, roadsides, O/C; *547*, *588*, *985*, *1566*, *Clonts 832*, *McDaniel 1434*

Hypericum mutilum L., IF, bottomland hardwood forests, pine-mixed hardwood forests, canals/drainage ditches (riparian–banks), C; *477*, *562*, *Brooks 402*, Theriot et al. (1993)

Hypericum punctatum Lam., IF, bottomland hardwood forests, canals/drainage ditches (riparian–banks), grass/forb meadows, O; *715*, *1588*, Theriot et al. (1993)

Hypericum sphaerocarpum Michx., BP, prairies, chalk outcrops, C(I); *374*, Leidolf and McDaniel (1998), *MacDonald 8718*, *McDaniel 31049*, Morris et al. (1993), *Smith 1413*

Hypericum stragulum W.P. Adams & E. Robson [= *H. hypericoides* (L.) Crantz ssp. *multicaule* (Michx. ex Willd.) E. Robson], IF, grass/forb meadows, R; *1549*

Triadenum tubulosum (Walter) Gleason, IF, bottomland hardwood forests; Theriot et al. (1993)

Triadenum walteri (J.G. Gmel.) Gleason, IF, bottomland hardwood forests, O; *908*, Theriot et al. (1993)

JUGLANDACEAE

Carya carolinae-septentrionalis (Ashe) Engl. & Graebn., PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, O; Morris et al. (1993), Pullen et al. (1968b), Theriot et al. (1993)

Carya cordiformis (Wangenh.) K. Koch, IF, bottomland hardwood forests, O; *Leidolf s.n.*, Theriot et al. (1993)

Carya glabra (Mill.) Sweet, IF, bottomland hardwood forests, xeric upland hardwood forests, pine forests, O; *1552*, Theriot et al. (1993)

Carya laciniosa (F. Michx.) G. Don, BP, bottomland hardwood forests, RR, **S2S3**; *161*, *McDaniel 3490*

Carya leiodermis Sarg. [= *C. glabra* (Mill.) Sweet var.*hirsuta* (Ashe) Ashe], IF, bottomland hard wood forests, **S2S3**; *Brooks 565*, Theriot et al. (1993)

Carya myristiciformis (F. Michx.) Nutt., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, O; *McDaniel 4233, 4324*, Morris et al. (1993)

Carya ovalis (Wangenh.) Sarg., IF, bottomland hardwood forests; Theriot et al. (1993)

Carya ovata (Mill.) K. Koch, IF, bottomland hardwood forests; Theriot et al. (1993)

Carya pallida (Ashe) Engl. & Graebn., BP, roadsides, O; *939*

Carya tomentosa (Lam. ex Poir.) Nutt. [= *C. alba* (L.) Nutt. ex Elliott], BP, IF, bottomland hardwood forests, xeric upland hardwood forests, pine forests, pine-mixed hardwood forests, O; *McDaniel 31612*, Theriot et al. (1993)

Juglans nigra L., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, U; *1513*, Morris et al. (1993)

LAMIACEAE (LABIATAE)

Blephilia ciliata (L.) Benth., BP, PR, prairies, chalk outcrops, roadsides, C; *269, 1444, Brooks 149 (MMNS), Carter 3013*, Leidolf and McDaniel (1998), *McDaniel 31043, 31069*, Morris et al. (1993), *Smith 2036*

Collinsonia tuberosa Michx., IF, bottomland hardwood forests, O; *906, McDaniel 26487*

Hedeoma hispida Pursh, BP, PR, IF, prairies, roadsides, O/A(I); *1505*, Leidolf and McDaniel (1998), *McDaniel 1820*, Pullen et al. (1968b)

**Lamium amplexicaule* L., BP, PR , roadsides, urban areas, A; *9, 80*, Jones (1976a), *Stewart 247*

**Lamium purpureum* L., BP, PR, roadsides, urban areas, C/A(I); *59, 142, 1210, Askew 35, McDaniel 1588*

Lycopus rubellus Moench, IF; *McDaniel 1566*

Lycopus virginicus L., IF, bottomland hardwood forests, rivers/creeks (riparian–mudflats); *McDaniel 1437, Smith 943*, Theriot et al. (1993)

**Mentha* × *rotundifolia* (L.) Huds. (pro sp.), IF, grass/forb meadows, A(I); *MacDonald 10902*

Monarda citriodora Cerv. ex Lag., BP, prairies, rivers/creeks (riparian–banks), O; *369*, Jones (1976a), *Bryson 3077*, Leidolf and McDaniel (1998), Morris et al. (1993), Pullen et al. (1968b)

Monarda fistulosa L., IF, roadsides, C; *Bruza 931*, Jones (1976a)

Physostegia angustifolia Fern., BP, IF, canals/drainage ditches (emergent), seepage areas, roadsides, A(I); *312, 1541*

Physostegia virginiana (L.) Benth., Jones (1976a)

Prunella vulgaris L., BP, IF, pine forests, prairies, prairie cedar woodlands, grass/forb meadows, roadsides, C; *174, 184, 235, 1443, Brooks 133*, Jones (1976a), Leidolf and McDaniel (1998), *Stewart 502*

Pycnanthemum albescens Torr. & A. Gray, IF, pine forests, pine-mixed hardwood forests, lakes/ponds/impoundments (riparian–banks), O/C; *810, Bruza 973*, Jones (1976a), *McDaniel 2197, 15729, 24534*

Pycnanthemum tenuifolium Schrad., IF, mesophytic upland hardwood forests, xeric upland hardwood forests, pine forests, canals/drainage ditches (riparian–banks), roadsides, O; *320, 337, Brooks 278, Bruza 598, Bryson 298, 683, Clonts 825*, Jones (1976a)

Salvia lyrata L., BP, PR, IF, bottomland hardwood forests, prairies, prairie cedar woodlands, roadsides, C; *136, 152, 187, Askew 70*, Jones (1976a), Leidolf and McDaniel (1998), Morris et al. (1993)

Scutellaria elliptica Muhl. ex Spreng., IF, mesophytic upland hardwood forests, O; *457*

Scutellaria incana Biehler, IF, pine forests, O; *594*

Scutellaria integrifolia L., IF, bottomland hardwood forests, roadsides, O; *325, Bryson 718*, Jones (1976a), *McDaniel 1092*, Theriot et al. (1993)

Scutellaria parvula Michx., BP, prairies, roadsides, O; *181, 212*, Jones (1976a), Leidolf and McDaniel (1998), Morris et al. (1993)

Teucrium canadense L., BP, IF, canals/drainage ditches (riparian–banks), O; *467, Bryson 724*

Trichostema brachiatum L., BP, IF, prairies, grass/forb meadows, O/C; *791*, Jones (1976a), Leidolf and McDaniel (1998), *MacDonald 7290, McDaniel 15506*

Trichostema dichotomum L., BP, IF, xeric upland hardwood forests, chalk outcrops, roadsides, R/O; *920, Brooks 486, McDaniel 31311, 31622*

LAURACEAE

Lindera benzoin (L.) Blume, IF, bottomland hardwood forests, R/O; *Leidolf s.n.*, Theriot et al. (1993)

Sassafras albidum (Nutt.) Nees, BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, pine forests, prairie cedar woodlands, roadsides, C; *140, 376, Askew 50, 63*, Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

LENTIBULARIACEAE

Utricularia gibba L., IF, lakes/ponds/impoundments (littoral–submergent), A(I); *696a*

LINACEAE

Linum medium (Planch.) Britton, BP, IF, prairies, roadsides, C; *285, 328*

Linum striatum Walter, IF, mesophytic upland hardwood forests, O; *556*

Linum sulcatum Riddell, BP, prairies, R, **S3S4**; *MacDonald s.n.*

LOGANIACEAE

Gelsemium sempervirens (L.) W.T. Aiton, IF, pine-mixed hardwood forests, C(I); *1594*

Spigelia marilandica L., PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, O; *249, 1499*, Morris et al. (1993)

LYTHRACEAE

Ammannia coccinea Rottb., BP, IF, rivers/creeks (emergent), cultivated fields, A(I); *691, Bryson 2607*, Jones (1975b), *McDaniel 25288*

**Cuphea carthagenensis* (Jacq.) J.F. Macbr., IF, mesophytic upland hardwood forests, O; *660*

Lythrum alatum Pursh var. *lanceolatum* (Elliott) Torr. & A. Gray ex Rothr., BP, prairies, rivers/creeks (riparian mudflats), A(I); *373*, Jones (1975b), Leidolf and McDaniel (1998), *McDaniel 25290, 31628*

Rotala ramosior (L.) Koehne, IF, canals/drainage ditches (riparian–mudflats), C; *537*, Jones (1975b)

MAGNOLIACEAE

Liriodendron tulipifera L., PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, O/C; *974, Morris 3101*, Theriot et al. (1993)

MALVACEAE

**Abutilon theophrasti* Medik., BP, cultivated fields; *Bryson 3419*

Anoda cristata (L.) Schltdl., BP, roadsides, R; *798*

Hibiscus laevis All., IF, rivers/creeks (riparian–banks), grass/forb meadows, O; *712, 716*

Hibiscus moscheutos L., BP, roadsides, U; *938*

Modiola caroliniana (L.) G. Don, PR, urban areas, U; *1204*

Sida rhombifolia L., BP, cultivated fields, A; *McDaniel 28085*

Sida spinosa L., BP, cultivated fields, roadsides, O/A; *409, 800, Bryson 3422*, Lowe (1921), *McDaniel 28084*

MELASTOMATACEAE

Rhexia mariana L. var. *mariana*, IF, xeric upland hardwood forests, pine forests, canals/drainage ditches (riparian–banks), roadsides, O/C; *440, Bryson 714, Clonts 817*

MELIACEAE

**Melia azedarach* L., PR, roadsides, U; *224*

MENISPERMACEAE

Calycocarpum lyonii (Pursh) A. Gray, BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, O; Lowe (1921), *McDaniel 24964*, Morris et al. (1993), Theriot et al. (1993)

Cocculus carolinus (L.) DC., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, prairie cedar woodlands, urban areas, U; *883, Brooks 582*, Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

Menispermum canadense L., PR, mesophytic upland hardwood forests, O/R, **S3S4**; *Morris 3088*, Morris et al. (1993)

MOLLUGINACEAE

Mollugo verticillata L., IF, canals/drainage ditches (emergent), O; *507*, Jones (1976b)

MORACEAE

**Broussonetia papyrifera* (L.) L'Hér. ex Vent.; Pullen et al. (1968b)

Maclura pomifera (Raf.) C.K. Schneid., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, prairie cedar woodlands, C; *202, 377, Brooks 467, Bryson 7439*, Leidolf and McDaniel (1998), *McDaniel 11622*, Morris et al. (1993)

Morus rubra L., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, prairie cedar woodlands, C; *156, Askew*

58, Bryson 7438, Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

MYRICACEAE

Myrica cerifera L., IF, pine forests, O; *121*

NELUMBONACEAE

Nelumbo lutea Willd., IF, lakes/ponds/impoundments (littoral–rooted-floating), O; *855*

NYCTAGINACEAE

Boerhavia erecta L.; Pullen et al. (1968b)

Mirabilis albida (Walter) Heimerl, BP, chalk outcrops, R; *McDaniel 13454*

NYMPHAEACEAE

Nymphaea odorata Aiton, lakes/ponds/impoundments (littoral–rooted-floating); Jones (1975b)

OLEACEAE

Fraxinus americana L., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, prairie cedar woodlands, O; Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

Fraxinus pennsylvanica Marshall, BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, lakes/ponds/impoundments (riparian banks), roadsides, O/C; *612, 1490, McDaniel 31639*, Morris et al. (1993), Theriot et al. (1993)

Fraxinus quadrangulata Michx., BP, PR, mesophytic upland hardwood forests, R, **S2**; *Bryson 10123, Gordon 2031*, Lowe (1921), *Morris 3083*, Morris et al. (1993), *Smith 1414*

**Ligustrum sinense* Lour., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, prairies, prairie cedar woodlands, C; *205, 854*, Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

ONAGRACEAE

Gaura biennis L., BP, IF, canals/drainage ditches (riparian–banks), O; *679, McDaniel 1565*

Gaura longiflora Spach; Jones (1974b)

Gaura parviflora Douglas ex Lehm.; Jones (1974b), Pullen et al. (1968b)

Ludwigia alternifolia L., IF, pine forests, grass/forb meadows, O; *502, 587, Brooks 328, Clonts 843*

Ludwigia decurrens Walter, IF, bottomland hardwood forests, canals/drainage ditches (emergent), O; *693*, Theriot et al. (1993)

Ludwigia glandulosa Walter, IF, bottomland hardwood forests, pine-mixed hardwood forests, canals/drainage ditches (emergent), O; *553, McDaniel 22135*, Theriot et al. (1993)

Ludwigia hirtella Raf., IF, pine-mixed hardwood forests, canals/drainage ditches (emergent), grass/forb meadows, O/C; *479, Brooks 327, Clonts 842, McDaniel 2537*

Ludwigia palustris (L.) Elliott, IF, canals/drainage ditches (emergent), lakes/ponds/impoundments (littoral–emergent), O; *452, 610*

Ludwigia peploides (Kunth) Raven, BP, rivers/creeks (emergent), canals/drainage ditches (emergent), O/A; *407, McDaniel 25287*

Oenothera biennis L., BP, IF, pine-mixed hardwood forests, roadsides, C; *850, Brooks 484*, Jones (1974b)

Oenothera fruticosa L. ssp. *glauca* (Michx.) Straley, IF, pine-mixed hardwood forests, seepage areas, O; *495, McDaniel 2532*

Oenothera laciniata Hill, BP, cultivated fields, A(I); *895, Bryson 3495*, Jones (1974b)

Oenothera linifolia Nutt., IF, roadsides, U; *Copeland s.n.*

Oenothera pilosella Raf., IF, roadsides, U; *Copeland s.n.*, Jones (1974b)

Oenothera speciosa Nutt., BP, prairies, roadsides, C; *188*, Leidolf and McDaniel (1998)

Oenothera triloba Nutt., BP, **SU**; *Donald s.n.* (MISSA)

OXALIDACEAE

Oxalis articulata Savigny ssp. *rubra* (St. -Hil.) Lourteig; Pullen et al. (1968b)

Oxalis dillenii Jacq., IF, bottomland hardwood forests, O; *263, 635*

Oxalis stricta L., BP, PR, IF, bottomland hardwood forests, rivers/creeks (riparian–banks), urban areas, O; *626, McDaniel 13440*, Theriot et al. (1993)

Oxalis violacea L., PR, IF, mesophytic upland hardwood forests, xeric upland hardwood forests, O; *1314*, Morris et al. (1993)

PAPAVERACEAE

Sanguinaria canadensis L., PR, mesophytic upland hardwood forests, A(I); *Morris 3089*, Morris et al. (1993)

PASSIFLORACEAE

Passiflora incarnata L., BP, IF, bottomland hardwood forests, lakes/ponds/impoundments

(riparian–banks), grass/forb meadows, roadsides, O/C; *329*, *1587*, *Bryson 709*, *Clonts 833*, Jones (1976b), *McDaniel 31323*

Passiflora lutea L., PR, IF, bottomland hardwood forests, xeric upland hardwood forests, O; *Clonts 822*, Jones (1976b), *Ray 4734* (MISSA), Theriot et al. (1993)

PENTHORACEAE

Penthorum sedoides L., IF, bottomland hardwood forests, mesophytic upland hardwood forests, rivers/creeks (emergent), canals/drainage ditches (emergent), A(l); *478*, *692*, *1584*, Theriot et al. (1993)

PHRYMACEAE

Phryma leptostachya L., PR, mesophytic upland hardwood forests, O; *461*, Morris et al. (1993), *Smith 1416*

PHYTOLACCACEAE

Phytolacca americana L., IF, roadsides, C; *522*

PLANTAGINACEAE

Plantago aristata Michx., IF, roadsides, C; *327*, *348*

**Plantago lanceolata* L., BP, roadsides, C; *213*, *400*

Plantago rugelii Decne., PR, IF, roadsides, urban areas, O; *344*, Pullen et al. (1968b), *Stewart 106*

Plantago virginica L., BP, prairies, urban areas, C/A(l); *183*, *McDaniel 31037*

PLATANACEAE

Platanus occidentalis L., PR, mesophytic upland hardwood forests, O; Morris et al. (1993)

POLEMONIACEAE

Phlox carolina L. ssp. *angusta* Wherry, IF, pine-mixed hardwood forests, seepage areas, O/C; *497*, *Brooks 119*, *McDaniel 15073*, Pullen et al. (1968b)

Phlox divaricata L., PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, O; *127*, Morris et al. (1993)

Phlox paniculata L., IF, C(l); Lowe (1921), *MacDonald 9721*

Phlox pilosa L., IF, pine forests, roadsides, O/A; *238*, *Brooks 118*, *McDaniel 1093*, *3145*

POLYGALACEAE

Polygala incarnata L., IF, pine forests, R; *1565*, *Bryson 713*

Polygala mariana Mill., IF, mesophytic upland hardwood forests, pine forests, pine-mixed hardwood forests, canals/drainage ditches (riparian–banks), lakes/ponds/impoundments (riparian–mudflats), O/C; *447*, *Bennett s.n.*, *Brooks 325*, *Bryson 731*, *Daugherty 2*, *McDaniel 2529*, *2641*, *13487*

Polygala nana (Michx.) DC., IF, mesophytic upland hardwood forests, pine forests, pine mixed hardwood forests, seepage areas, O/C; *243*, *1483*, *1495*, *1564*, *Bryson 702*, *708*, *McDaniel 2535*

Polygala sanguinea L., IF, bottomland hardwood forests, pine forests, grass/forb meadows, roadsides, O; *323*, *582*, *Bryson 680*, *Clonts 829*, *845*

POLYGONACEAE

Brunnichia ovata (Walter) Shinners, BP, IF, bottomland hardwood forests, lakes/ponds/impoundments (riparian–banks), O/A(l); *599*, Jones (1975b), *McDaniel 31616*, Theriot et al. (1993)

**Polygonum aviculare* L., BP, IF, lakes/ponds/impoundments (riparian–mudflats), cultivated fields, A(l); *404*, *608*, Jones (1975b)

**Polygonum cespitosum* Blume, IF, lakes/ponds/impoundments (riparian–mudflats), O; *979*

Polygonum densiflorum Meisn., IF, swamp forests, A; *McDaniel 24537*, *Stewart 124*

Polygonum hirsutum Walter, PR, canals/drainage ditches (emergent), R; Leidolf pers. obs.

Polygonum hydropiperoides Michx., IF, bottomland hardwood forests, canals/drainage ditches (emergent), lakes/ponds/impoundments (littoral–emergent), C/A; *450*, *856*, *Bruza 962*, *981*, Jones (1975b), Theriot et al. (1993)

Polygonum lapathifolium L., BP, canals/drainage ditches (emergent), lakes/ponds/impoundments (littoral–emergent), C; *893*, Jones (1975b), *McDaniel 31330*, *31641*

Polygonum pensylvanicum L., BP, IF, canals/drainage ditches (emergent), lakes/ponds/impoundments (littoral–emergent), roadsides, U/C; *410*, *597*, *882*, Jones (1975b)

Polygonum punctatum Elliott; Jones (1975b)

Polygonum virginianum L., IF, bottomland hardwood forests, pine-mixed hardwood forests, O; *721*, Jones (1975b), *Leidolf s.n.*, Theriot et al. (1993)

**Rumex acetosella* L.; Jones (1975b)

Rumex altissimum Alph. Wood; Jones (1975b)

**Rumex crispus* L., BP, IF, cultivated fields, road sides, C; *231, Bryson 3496*, Jones (1975b)

Rumex hastatulus Baldwin, BP, IF, roadsides, urban areas, C(I)/A(I); *468, 1312, Barbour 6685*, Jones (1975b), Pullen et al. (1968b)

**Rumex pulcher* L.; Jones (1975b), Pullen et al. (1968b)

PORTULACACEAE

Claytonia virginica L., PR, IF, bottomland hardwood forests, grass/forb meadows, roadsides, O/C; *34*, Lowe (1921), *McDaniel 1680*, Morris et al. (1993)

PRIMULACEAE

Anagallis minima (L.) Krause, BP, xeric upland hardwood forests; *McDaniel 29336a*

Dodecatheon meadia L., BP, PR, prairies, prairie cedar woodlands, R, **S2**; *Bryson 5400*, Lowe (1921), *Morris 3095*, Morris et al. (1993)

Lysimachia ciliata L., IF, seepage areas, U; *Bryson 712*

Lysimachia lanceolata Walter; Jones (1976b)

**Lysimachia nummularia* L., BP, canals/drainage ditches (riparian–banks, emergent), R; *408*

Samolus valerandi L. ssp. *parviflorus* (Raf.) Hultén, BP, IF, rivers/creeks (riparian–mudflats), canals/drainage ditches (emergent), O; *448, 1487 (R448), Bryson 3076*, Jones (1976b)

RANUNCULACEAE

Actaea pachypoda Elliott, BP, PR; *Gordon 2062 (MMNS)*

Anemone caroliniana Walter, BP, prairies, chalk outcrops, roadsides, O/C; *115, 143, 1267 (R115)*, Leidolf and McDaniel (1998), *Morris 3077*, Morris et al. (1993)

Anemone virginiana L., PR, bottomland hardwood forests, mesophytic upland hardwood forests, O; Lowe (1921), Morris et al. (1993)

Clematis crispa L., PR, IF, bottomland hardwood forests, canals/drainage ditches (riparian–banks), roadsides, O; *534*, Morris et al. (1993)

**Clematis terniflora* DC., BP, PR, prairie cedar woodlands, roadsides, O; *707, McDaniel 31617*

Delphinium carolinianum Walter ssp. *carolinianum*, BP, prairies, O/A(I); *273, 1509 (R273), Brooks 154, MacDonald 8716, McDaniel 31039*

Delphinium tricorne Michx., BP, prairies, C(I), **S2**; *McDaniel 31027*

Myosurus minimus L., BP, cultivated fields, C(I); *1271, 1284, Bryson 3500*

Ranunculus abortivus L., BP, PR, mesophytic upland hardwood forests, xeric upland hardwood forests, lakes/ponds/impoundments (riparian–mudflats), urban areas, C; *1278, 1292, 1335, McDaniel 1589*

**Ranunculus arvensis* L., BP, cultivated fields, A(I); *1273, 1343a*

Ranunculus fascicularis Muhl. ex Bigelow, BP, PR, mesophytic upland hardwood forests, prairies, O; *5, 67, 117(R5)*, Leidolf and McDaniel (1998), *McDaniel 2326*

Ranunculus hispidus Michx. var. *hispidus*, BP, cultivated fields, A; *McDaniel 1826*

Ranunculus hispidus Michx. var. *nitidus* (Chapm.) T. Duncan, BP, urban areas, A; *McDaniel 24967*

Ranunculus micranthus Nutt., BP, xeric upland hardwood forests, O; *1360*

**Ranunculus muricatus* L., BP, PR, IF, bottomland hardwood forests, cultivated fields, urban areas, C/A(I); *1275, 1282, Bryson 3497, Clonts 744, McDaniel 1689*

**Ranunculus parviflorus* L., BP, cultivated fields; *Bryson 3494*

Ranunculus pusillus Poir., BP, IF, canals/drainage ditches (riparian–banks), grass/forb meadows, O; *1345, 1363*

Ranunculus recurvatus Poir., BP, PR, mesophytic upland hardwood forests, R/U; *1349, McDaniel 31023*

**Ranunculus sardous* Crantz, BP, PR, roadsides, C/A; *68, 77, McDaniel 31058*

Thalictrum debile Buckley, BP, mesophytic upland hardwood forests, A, **S1S2**; *McDaniel 31385*

Thalictrum thalictroides (L.) Eames & B. Boivin, PR, IF, mesophytic upland hardwood forests, O; *89, Askew 42*, Morris et al. (1993)

RHAMNACEAE

Berchemia scandens (Hill) K. Koch, BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, prairies, prairie cedar woodlands, chalk outcrops, O/C; *227, Bryson 7441, Carter 3002*, Leidolf and McDaniel (1998), *McDaniel 10581*, Morris et al. (1993), Theriot et al. (1993)

Ceanothus americanus L., BP, prairie cedar woodlands, chalk outcrops, O/A(I); *286, 432*, Leidolf and McDaniel (1998), *McDaniel 13452, 31065*, Morris et al. (1993)

Rhamnus caroliniana Walter [= *Frangula caroliniana* (Walter) A. Gray], BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, prairie cedar woodlands, chalk outcrops, O/C; *388*, *1518*, Leidolf and McDaniel (1998), *MacDonald 8717*, *McDaniel 31611*, Morris et al. (1993)

Rhamnus lanceolata Pursh, BP, PR, prairie cedar woodlands, chalk outcrops, C(I), **S2**; *831*, *1326 (R831)*, *1340*, Leidolf and McDaniel (1998), *MacDonald 8150*, Pullen et al. (1968b), *Ray 8008* (MISSA), *Smith 1447*, *1937*

ROSACEAE

Agrimonia rostellata Wallr., BP, PR, mesophytic upland hardwood forests, xeric upland hardwood forests, O/A(I); *671*, *McDaniel 31611*

Amelanchier arborea (F. Michx.) Fernald, IF, bottomland hardwood forests, O; *Leidolf s.n.*, Theriot et al. (1993)

**Aphanes microcarpa* (Boiss. & Reut.) Rothm., PR, roadsides, urban areas, O/C; *1213*, *1506*

Crataegus calpodendron (Ehrh.) Medik., PR, mesophytic upland hardwood forests, O, **S?**; *216*, *Morris 3087*, Morris et al. (1993)

Crataegus crus-galli L., BP, IF, pine-mixed hardwood forests, prairie cedar woodlands, roadsides, O; *279*, *697*, Leidolf and McDaniel (1998)

Crataegus engelmannii Sarg., BP, xeric upland hardwood forests, prairie cedar woodlands, O; *206*, Leidolf and McDaniel (1998), *McDaniel 11619*

Crataegus marshallii Eggl., PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine-mixed hardwood forests, O; *135*, *1370*, *Leidolf s.n.*, *McDaniel 1687*, Morris et al. (1993), Theriot et al. (1993)

Crataegus pruinosa (H.L. Wendl.) K. Koch, IF, bottomland hardwood forests, O; *Leidolf s.n.*, Theriot et al. (1993)

Crataegus spathulata Michx., BP, IF, bottomland hardwood forests, xeric upland hardwood forests, R/O; *Leidolf s.n.*, *McDaniel 3493*, *Morris 3102*, Morris et al. (1993), Theriot et al. (1993)

Crataegus viridis L., IF, bottomland hardwood forests, R/O; *Leidolf s.n.*, Theriot et al. (1993)

**Duchesnea indica* (Andrz.) Focke, PR, mesophytic upland hardwood forests, O; *1306*

Fragaria virginiana Duchesne, BP, xeric upland hardwood forests, prairie cedar woodlands, O/C; *168*, *214*, *1328*, *Askew 27*, *Morris 3078*, Morris et al. (1993)

Geum canadense Jacq., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, rivers/creeks (riparian–banks), C; *304*, *Bryson 3079*, Morris et al. (1993)

Potentilla simplex Michx., BP, prairies, O; *169*, *1365*

Prunus americana Marshall, BP, IF, rivers/creeks (riparian–banks), roadsides, U; *103*, *141*, *437*

Prunus angustifolia Marshall, BP, PR, IF, prairies, chalk outcrops, roadsides, C; *30*, *31*, *32*, *277*

Prunus mexicana S. Watson, BP, IF, bottomland hardwood forests, pine-mixed hardwood forests, O; *43*, Morris et al. (1993), Pullen et al. (1968b), Theriot et al. (1993)

Prunus serotina Ehrh., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, pine-mixed hardwood forests, rivers/creeks (riparian–banks), C; *73*, *Askew 49*, Morris et al. (1993), Theriot et al. (1993)

**Pyracantha coccinea* M. Roem., BP, prairies, chalk outcrops, R/C(I); *207*, *621*, Leidolf and McDaniel (1998), *MacDonald 7531*, *8150b*, *McDaniel 15513*, *29756*

**Pyrus calleryana* Decne., BP, IF, pine forests, prairie cedar woodlands, U; *805*, *828*, Leidolf and McDaniel (1998)

Rosa carolina L., BP, prairies, prairie cedar woodlands, O; *842*, *1453*, *Brooks 146*, Leidolf and McDaniel (1998)

**Rosa chinensis* Jacq., BP, IF, mesophytic upland hardwood forests, roadsides, R/U; *208*, *1488*

**Rosa multiflora* Thunb. ex Murray, BP, PR, bottomland hardwood forests, prairies, prairie cedar woodlands, roadsides, C; *8*, *177*, Leidolf and McDaniel (1998), Morris et al. (1993)

Rubus argutus Link, BP, PR, IF, bottomland hardwood forests, prairies, O; Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

Rubus betulifolius Small [= *R. argutus* Link], PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, roadsides, C; *154*, *1373*

Rubus cuneifolius Pursh, BP, prairies, prairie cedar woodlands, O; *McDaniel 31139*

Rubus flagellaris Willd., IF, pine-mixed hardwood forests, O; *122*

Rubus trivialis Michx., BP, IF, bottomland hard-

wood forests, C; *McDaniel 2324*, Theriot et al. (1993)

RUBIACEAE

Cephalanthus occidentalis L., IF, bottomland hardwood forests, canals/drainage ditches (riparian–banks), lakes/ponds/impoundments (riparian–banks), C; *584, 607*, Jones (1976b), Theriot et al. (1993)

**Cruciata pedemontana* (Bellardi) Ehrend., BP, roadsides, C(I); *MacDonald 9305*

Diodia teres Walter, IF, roadsides, O; *439*, Jones (1976b)

Diodia virginiana L., BP, IF, bottomland hardwood forests, lakes/ponds/impoundments (riparian–mudflats), cultivated fields, roadsides, C; *416, 611*, Theriot et al. (1993)

Galium aparine L., BP, PR, lakes/ponds/impoundments (riparian–banks), roadsides, C; *155*, Jones (1976b), *McDaniel 31049*

Galium circaezans Michx., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, prairie cedar woodlands, C; *303*, Jones (1976b), Leidolf and McDaniel (1998), Morris et al. (1993)

Galium obtusum Bigelow, IF, bottomland hard wood forests, A(I); *245*, Jones (1976b)

**Galium parisiense* L., BP, roadsides, A(I); *314*

Galium pilosum Aiton, BP, IF, xeric upland hardwood forests, grass/forb meadows, U; *1590, Clonts 826*, Jones (1976b)

Galium tinctorium (L.) Scop.; Jones (1976b)

Galium uniflorum Michx., IF, mesophytic upland hardwood forests, O; *446*

Galium virgatum Nutt., BP, prairies, O; *146*, Leidolf and McDaniel (1998)

Hedyotis australis W.H. Lewis & D.M. Moore [= *Houstonia micrantha* (Shinners) Terrell], IF, urban areas, U/C(I); *1316, MacDonald 8236*

Hedyotis crassifolia Raf. [– *Houstonia pusilla* Schoepf], BP, PR, IF, prairies, grass/forb meadows, urban areas, C; *42, 62, 132*, Jones (1976b), Leidolf and McDaniel (1998)

Hedyotis nigricans (Lam.) Fosberg, BP, prairies, chalk outcrops, O; *294*, Jones (1976b), Leidolf and McDaniel (1998), *McDaniel 15512*

Hedyotis purpurea (L.) Torr. & A. Gray var. *calycosa* (A. Gray) Fosberg, BP, IF, bottomland hard wood forests, prairies, prairie cedar wood lands, grass/forb meadows, roadsides, C; *165, 185, 257, 1341 (R185), 1371, Brooks 125, Bryson 57, 715*, Jones (1976b), Leidolf and McDaniel (1998), *McDaniel 10523*, Morris et al. (1993), Theriot et al. (1993)

Mitchella repens L., IF, bottomland hardwood forests, mesophytic upland hardwood forests, C; *251, 1580, Brooks 474*, Jones (1976b), Theriot et al. (1993)

Oldenlandia boscii (DC.) Chapm., IF, pine forests, pine-mixed hardwood forests, canals/drainage ditches (riparian–banks), C/A; *505, Brooks 322, Copeland s.n., McDaniel 2661*

Oldenlandia uniflora L., IF, pine mixed hardwood forests; *Brooks 324*

Richardia scabra L.; Jones (1976b)

**Sherardia arvensis* L., PR, roadsides, urban areas, C/A; *102*, Jones (1976b), *McDaniel 1610*, Pullen et al. (1968b)

Spermacoce glabra Michx., BP, canals/drainage ditches (riparian–banks), roadsides, O; *631*

RUTACEAE

**Poncirus trifoliata* (L.) Raf., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, roadsides, U; *69, 870*, Theriot et al. (1993)

Ptelea trifoliata L., IF, bottomland hardwood forests, rivers/creeks (riparian–banks), U, **S3S4**; *260, 717*

Zanthoxylum clava-herculis L., BP, PR, mesophytic upland hardwood forests, xeric upland hard wood forests, U; *935, McDaniel 1988, 24448, 31042*, Morris et al. (1993)

SALICACEAE

**Populus alba* L., IF, roadsides, urban areas, U; *1542, 1545*

Populus deltoides W. Bartram ex Marshall, PR, bottomland hardwood forests, mesophytic up land hardwood forests, C; *1322*, Morris et al. (1993)

Salix exigua Nutt., BP, canals/drainage ditches (riparian–banks), R; *613*, Lowe (1921)

Salix humilis Marshall, IF, pine forests, pine-mixed hardwood forests, lakes/ponds/impoundments (riparian–banks), seepage areas, roadsides, U; *508, 1501 (R508), Edwards s.n., MacDonald 6132, McDaniel 2840*

Salix nigra Marsnall, BP, IF, bottomland hardwood forests, rivers/creeks (riparian–banks/mudflats), canals/drainage ditches (riparian–

banks), C; *131*, *1362*, *Askew 129*, Theriot et al. (1993)

SAPINDACEAE

Cardiospermum halicacabum L., IF, rivers/creeks (riparian–banks), canals/drainage ditches (riparian–banks), cultivated fields, O; *694*, *710*, Pullen et al. (1968b), *Smith 942*

SAPOTACEAE

Bumelia lycioides (L.) Pers. [= *Sideroxylon lycioides* L.], BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, prairie cedar woodlands, rivers/creeks (riparian–banks), C; *434*, *688*, *827*, Leidolf and McDaniel (1998), Morris et al. (1993)

SAURURACEAE

Saururus cernuus L., PR, IF, bottomland hardwood forests, swamp forests, O; *341*, Jones (1975b), *McDaniel 28882*, Theriot et al. (1993)

SCROPHULARIACEAE

Agalinis fasciculata (Elliott) Raf., IF, pine forests, O; *880*

Agalinis gattingeri (Small) Small ex Britton, BP, prairies, O; *929*, Leidolf and McDaniel (1998)

Agalinis heterophylla (Nutt.) Small ex Britton, BP, R; *McDaniel 31653*

Agalinis pseudaphylla (Pennell) Shinners, BP, prairies, R, **S2**; *829*, Leidolf and McDaniel (1998), *McDaniel 15617*

Agalinis purpurea (L.) Pennell, BP, IF, pine forests, prairies, roadsides, C(I); *871*, *931*, *960*, Leidolf and McDaniel (1998), *McDaniel 24535*, *31308*, *Stewart 117*

Agalinis tenuifolia (Vahl) Raf., BP, IF, pine-mixed hardwood forests, chalk outcrops, roadsides, O; *989*, *McDaniel 14664*, *31312*

Aureolaria flava (L.) Farw., BP, IF, xeric upland hardwood forests, pine-mixed hardwood forests, roadsides, U/A(I); *718*, *Clonts 1400*, *McDaniel 31623*

Aureolaria pectinata (Nutt.) Pennell, IF, pine-mixed hardwood forests, U/A(I); *1538*, *McDaniel 2724*

Buchnera floridana Gandog. [= *B. americana* L.], BP, IF, prairies, seepage areas, O/R; *296*, *371 (R296)*, *539*, Leidolf and McDaniel (1998), *McDaniel 13450*, *31086*

Dasistoma macrophylla (Nutt.) Raf., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, roadsides, O, **S3S4**; *433*, *1601*, Morris et al. (1993)

Epifagus virginiana (L.) Barton, IF, bottomland hardwood forests, A(I); *943*

Gratiola neglecta Torr., IF, bottomland hardwood forests, canals/drainage ditches (emergent), grass/forb meadows, C; *264*, *1347*, *McDaniel 1679*

Gratiola pilosa Michx., IF, seepage areas, O; *481*

Gratiola virginiana L., IF, bottomland hardwood forests, swamp forests, canals/drainage ditches (emergent), O/A(I); *1294*, *1440*, *McDaniel 2451*

Leucospora multifida (Michx.) Nutt., BP, cultivated fields, O; *422*

Linaria canadensis (L.) Chaz. [= *Nuttalanthus canadensis* (L.) D.A. Sutton], BP, cultivated fields, A(I); *1281*

Lindernia dubia (L.) Pennell, BP, IF, bottomland hardwood forests, rivers/creeks (riparian–mudflats), O; *McDaniel 25289*, Theriot et al. (1993)

Mecardonia acuminata (Walter) Small, IF, pine forests, seepage areas, lakes/ponds/impoundments (riparian–banks), O; *646*, *652*, *Copeland s.n.*

Micranthemum umbrosum (J.F. Gmel.) S.F. Blake, IF, lakes/ponds/impoundments (riparian–mudflats), O/C; *1595*, *McDaniel 1570*, *1570a*

Mimulus alatus Aiton, BP, IF, bottomland hardwood forests, rivers/creeks (riparian–banks/mudflats), canals/drainage ditches (riparian–banks), O; *554*, *672*, Theriot et al. (1993)

**Parentucellia viscosa* (L.) Caruel, PR, urban areas, C(I); *MacDonald 9377*

Pedicularis canadensis L., PR, mesophytic upland hardwood forests, O; *Smith 1930*

Penstemon digitalis Nutt. ex Sims, BP, PR, mesophytic upland hardwood forests, prairies, prairie cedar woodlands, rivers/creeks (riparian–banks), O; *217*, *1452*, *Morris 3098*

Penstemon laevigatus Aiton, BP, prairies, roadsides, O; *211*, *1466*

Penstemon tenuiflorus Pennell, BP, prairies, prairie cedar woodlands, chalk outcrops, roadsides, U/C(I), **S2S3**; *270*, *Bryson 129*, *7442*, *McDaniel 10584*, *31020*, *Morris 3079*, Morris et al. (1993), *Stewart 357*

Penstemon tubiflorus Nutt., BP, PR, mesophytic upland hardwood forests, lakes/ponds/im-

poundments (riparian–banks), R/U; *McDaniel 31051*, Morris et al. (1993)

Scrophularia marilandica L., PR, mesophytic upland hardwood forests, U/O; *McDaniel 28889*, Morris et al. (1993)

Seymeria cassioides (J.F. Gmel.) S.F. Blake, IF, pine forests, pine-mixed hardwood forests, C/A(l); *959, McDaniel 22134, 24536*

Tomanthera auriculata (Michx.) Raf. [= *Agalinis auriculata* (Michx.) S.F. Blake], BP, prairies, roadsides, RR, **S1**; *928, 930*, Leidolf and McDaniel (1998), *McDaniel 15621*

**Verbascum blattaria* L., BP, prairies, roadsides, O; *318, Brooks 156*

**Verbascum thapsus* L., IF, roadsides, C(l); *521*

**Veronica arvensis* L., BP, roadsides, C; *70, 159*

Veronica peregrina L., BP, PR, cultivated fields, urban areas, C; *1208, 1274, 1285*

**Veronica persica* Poir., PR, urban areas, O; *1207*

SIMAROUBACEAE

**Ailanthus altissima* (Mill.) Swingle, PR, urban areas, R; *Smith 363*

SOLANACEAE

**Datura stramonium* L., BP, urban areas; *Carraway 490*

Physalis angulata L., BP, IF, chalk outcrops, cultivated fields, grass/forb meadows, O; *417, 520, 713, Clonts 1408, McDaniel 22195*

Physalis heterophylla Nees, BP, PR, mesophytic upland hardwood forests, lakes/ponds/impoundments (riparian–mudflats), O; *McDaniel 31047*, Morris et al. (1993)

Physalis pubescens L.; Pullen et al. (1968b)

Physalis virginiana Mill., BP, IF, pine forests, rivers/creeks (riparian–mudflats), canals/drainage ditches (riparian–banks), O; *685, 835, McDaniel 21234*

Solanum carolinense L., IF, roadsides, O; *252, Clonts 821*

Solanum ptychanthum Dunal, PR, mesophytic upland hardwood forests, U; *890*

STAPHYLEACEAE

Staphylea trifolia L., IF, bottomland hardwood forests, A(l), **S3**; *280, 352 (R280), 978 (R280), 1368 (R280), Blocker s.n.* (MISSA), *Channell s.n.* (MISSA), Theriot et al. (1993)

STYRACACEAE

Styrax americanus Lam., IF, bottomland hardwood forests, lakes/ponds/impoundments (riparian–banks), U/C; *949, Leidolf s.n., McDaniel 1820a*, Theriot et al. (1993)

SYMPLOCACEAE

Symplocos tinctoria (L.) L'Hér., IF, bottomland hardwood forests, C; *903, 948, Askew 47*, Theriot et al. (1993)

TILIACEAE

Tilia americana L., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, rivers/creeks (riparian–banks), O/C(l); *Bryson 7430, Morris 3085*, Morris et al. (1993)

ULMACEAE

Celtis laevigata Willd., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, pine-mixed hardwood forests, prairie cedar woodlands, C; *233, 936*, Leidolf and McDaniel (1998), Lowe (1921), Morris et al. (1993), Theriot et al. (1993)

Planera aquatica J.F. Gmel., IF, bottomland hardwood forests, rivers/creeks (riparian–banks), R/O; *Leidolf s.n.*, Theriot et al. (1993)

Ulmus alata Michx., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, pine-mixed hardwood forests, prairies, prairie cedar woodlands, chalk outcrops, lakes/ponds/impoundments (riparian–banks), roadsides, C; *39, 350, 634, 1336*, Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

Ulmus americana L., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, pine-mixed hardwood forests, roadsides, C; *24, 37*, Morris et al. (1993), Theriot et al. (1993)

Ulmus rubra Muhl., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, prairie cedar woodlands, rivers/creeks (riparian–banks), O; *104*, Leidolf and McDaniel (1998), Morris et al. (1993)

Ulmus serotina Sarg., PR, mesophytic upland hardwood forests, R, **S3?**; *884, Anderson s.n.* (MISSA), *Crawford s.n.* (MISSA), *Henry s.n.* (MISSA), *Howell s.n.* (MISSA), *Johnson s.n.* (MISSA), *McDaniel 1046, Smith 1022*

URTICACEAE

Boehmeria cylindrica (L.) Sw., BP, IF, bottomland

hardwood forests, rivers/creeks (riparian–mudflats), A(I); *673*, Theriot et al. (1993)

Parietaria pensylvanica Muhl. ex Willd., BP, lakes/ponds/impoundments (riparian–mudflats), A(I); *McDaniel 31056*

Pilea pumila (L.) A. Gray, IF, bottomland hardwood forests, swamp forests, rivers/creeks (riparian–banks), O/A; *905*, *Smith 944*

VALERIANACEAE

**Valerianella locusta* (L.) Betcke, PR, urban areas, O; *McDaniel 21186*

Valerianella radiata (L.) Dufr., BP, PR, IF, bottomland hardwood forests, roadsides, urban areas, C/A; *101*, *Askew 66*, Jones (1976b), *McDaniel 1666*, *31036*

VERBENACEAE

Callicarpa americana L., BP, IF, bottomland hardwood forests, mesophytic upland hardwood forests, grass/forb meadows, C; *449*, *857*, *Clonts 844*, Morris et al. (1993), Theriot et al. (1993)

Lippia lanceolata Michx. [= *Phyla lanceolata* (Michx.) Greene], BP, chalk outcrops, cultivated fields, O; *415*, *McDaniel 22926*

Verbena bipinnatifida Nutt. [= *Glandularia bipinnatifida* (Nutt.) Nutt. var. *bipinnatifida*], BP, IF, prairies, chalk outcrops, roadsides, R/C; *167*, *275*, *1329*, *Bruza 925*, *Bryson 7446*, *McDaniel 13449*, *31019*, *Morris 3082*, Morris et al. (1993), Pullen et al. (1968b)

**Verbena bonariensis* L., IF, grass/forb meadows, U/C(I); *1655*, *Bruza 963*

**Verbena brasiliensis* Vell., BP, PR, IF, grass/forb meadows, roadsides, urban areas, C/A(I); *290*, *463*, *1572*, *Bryson 730*, *Scruggs 100*

Verbena canadensis (L.) Britton [= *Glandularia candensis* (L.) Nutt.], BP; Morris et al. (1993)

**Verbena rigida* Spreng., PR, IF, grass/forb meadows, roadsides, U; *847*, *1532*

Verbena simplex Lehm., BP, IF, prairies, chalk outcrops, roadsides, O; *267*, *298*, *Clonts 815*, Leidolf and McDaniel (1998), Lowe (1921), *McDaniel 13448*, *31040*, *Morris 3080*, Morris et al. (1993), *Sundell 1538*

Verbena urticifolia L., BP, canals/drainage ditches (riparian–banks), roadsides, U; *833*, Lowe (1921)

VIOLACEAE

Hybanthus concolor (T.F. Forst.) Spreng., PR, mesophytic upland hardwood forests, C(I), **S2**; *Channell s.n.* (MISSA), *Mckee s.n.* (MISSA), *Ray 8214* (MISSA), *Smith 1929*

Viola affinis Leconte, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine forests, canals/drainage ditches (riparian–banks), C; *41*, *86*, *98*, *McDaniel 2884*, Morris et al. (1993), Theriot et al. (1993)

Viola bicolor Pursh, PR, roadsides, C; *60*

Viola palmata L., PR, IF, mesophytic upland hardwood forests, O; *97*, *123*, *153(R123)*

Viola primulifolia L., IF, mesophytic upland hardwood forests, R/O; *198*, *Bryson 963*

Viola sagittata Aiton, BP, IF, bottomland hardwood forests, pine forests, pine-mixed hardwood forests, chalk outcrops, rivers/creeks (riparian–banks), C; *87*, *106*, *118*, *Bryson 5392*, *McDaniel 1590*, *1608*

VISCACEAE

Phoradendron leucarpum (Raf.) Reveal & M.C. Johnst., PR, urban areas, C; *1203*

VITACEAE

Ampelopsis arborea (L.) Koehne, BP, IF, bottomland hardwood forests, xeric upland hardwood forests, prairie cedar woodlands, C; *469*, Leidolf and McDaniel (1998), *McDaniel 31634*, *31655*, Theriot et al. (1993)

Ampelopsis cordata Michx., BP, PR, IF, bottomland hardwood forests, roadsides, urban areas, C; *614*, *1491*, *1533*

Cissus incisa Des Moul., PR, urban areas; *McDaniel 9786*

Parthenocissus quinquefolia (L.) Planch., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, prairie cedar woodlands, O; Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

Vitis aestivalis Michx., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, prairie cedar woodlands, chalk outcrops, O; Leidolf and McDaniel (1998), Morris et al. (1993), Theriot et al. (1993)

Vitis cinerea (Engelm.) Millard, BP, IF, bottomland hardwood forests, pine-mixed hardwood forests, urban areas, R/O; *1446*, *1496*, *1599*, Theriot et al. (1993)

Vitis rotundifolia Michx., PR, IF, bottomland hardwood forests, pine forests, pine-mixed hardwood forests, C; *1593*, Morris et al. (1993), Theriot et al. (1993)

LILIOPSIDA

AGAVACEAE

Manfreda virginica (L.) Salisb. ex Rose, BP, IF, prairies, roadsides, C; *425, 627, 802, 839, Bruza 967*, Leidolf and McDaniel (1998), *Locke s.n.* (MISSA), *Ray 49* (MISSA)

ALISMATACEAE

Alisma subcordatum Raf., IF, canals/drainage ditches (emergent), lakes/ponds/impoundments (littoral–emergent), RR, **SH**; *Frasier s.n.*, Leidolf pers. obs., *MacDonald 10884*

Echinodorus cordifolius (L.) Griseb., IF, lakes/ponds/impoundments (riparian–mudflats, littoral–emergent), O; *726, Easley s.n.* (MISSA), Jones (1974a)

Sagittaria calycina Engelm.; *Hare s.n.* (MISSA)

Sagittaria lancifolia L.; *Blocker s.n.* (MISSA), Jones (1974a)

Sagittaria platyphylla (Engelm.) J.G. Sm., IF, lakes/ponds/impoundments (riparian–mudflats, littoral–emergent), O; *727*

ALLIACEAE

**Allium ampeloprasum* L., BP, grass/forb meadows, roadsides, O; *311*

Allium canadense L., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, prairies, lakes/ponds/impoundments (riparian–mudflats), grass/forb meadows, urban areas, O/A; *276, Fisher 82* (MISSA), Leidolf and McDaniel (1998), *McDaniel 31054*, Morris et al. (1993)

Allium mobilense Regel [= *A. canadense* L. var. *mobilense* (Regel) Ownbey], PR, urban areas; *Prescott s.n.* (MISSA)

**Allium vineale* L., BP, prairies, roadsides, O; *310*, Leidolf and McDaniel (1998)

Nothoscordum bivalve (L.) Britton, BP, PR, mesophytic upland hardwood forests, prairies, prairie cedar woodlands, C; *61, 113*, Leidolf and McDaniel (1998), *Mitchell s.n.* (MISSA), *Murphy s.n.* (MISSA), *Persons s.n.* (MISSA), *Rainwater s.n.* (MISSA), *Sistrunk s.n.* (MISSA), *Stauffer s.n.* (MISSA), *Tringle s.n.* (MISSA)

AMARYLLIDACEAE

**Leucojum aestivum* L., IF, bottomland hardwood forests, R; *Askew 46*

**Lycoris radiata* (L'Hér.) Herb., PR, roadsides, urban areas, O; *996*

**Narcissus biflorus* Curtis [= *N.* × *medioluteus* Mill. (pro sp.)], PR, roadsides, urban areas, O; *33*

**Narcissus* × *incomparabilis* Mill., BP, roadsides, urban areas, O; *79*

**Narcissus jonquilla* L., PR, roadsides, urban areas, O; *22*

ARACEAE

Arisaema dracontium (L.) Schott, BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, lakes/ponds/impoundments (riparian–mudflats), A(l); *218, 258, Brown s.n.* (MISSA), Jones (1974a), Lowe (1921), *McDaniel 31057*, Morris et al. (1993), Theriot et al. (1993)

Arisaema quinatum (Buckley) Schott [= *A. triphyllum* (L.) Schott ssp. *quinatum* (Buckley) Huttleston], PR, mesophytic upland hardwood forests, R; Morris et al. (1993), *Tracy s.n.* (MISSA)

Arisaema triphyllum (L.) Schott, PR, bottomland hardwood forests, mesophytic upland hardwood forests, U; *147*, *Channell s.n.* (MISSA), Jones (1974a), *Moore s.n.* (MISSA)

ARECACEAE (PALMAE)

Sabal minor (Jacq.) Pers., IF, bottomland hardwood forests, pine-mixed hardwood forests, A(l); *714, Askew 61, McDaniel 2549*

ASPARAGACEAE

**Asparagus officinalis* L., BP, PR, prairies, roadsides, urban areas, U; *804*, *Channell s.n.* (MISSA), *18* (MISSA), *Christian s.n.* (MISSA), *Clonts 490*, Leidolf and McDaniel (1998)

COMMELINACEAE

**Commelina communis* L., BP, canals/drainage ditches (emergent), roadsides, C; *797*, Jones (1976b)

Commelina diffusa Burm.f., PR, canals/drainage ditches (emergent), urban areas, O; *923*

Commelina virginica L., BP, IF, bottomland hardwood forests, rivers/creeks (riparian–mudflats), canals/drainage ditches (emergent), C; *675, 695, 1374, Brooks 400*, Jones (1976b), *Moore s.n.* (MISSA), *Stauffer s.n.* (MISSA)

Tradescantia ohiensis Raf., IF, pine forests, roadsides, C; *256, 326, Brooks 124, Easley s.n.* (MISSA), *Funchess s.n.* (MISSA), Jones (1976b), *Rainwater s.n.* (MISSA), *Stauffer s.n.* (MISSA)

Tradescantia virginiana L., BP, IF, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, O/C; *Persons s.n.* (MISSA), *Presley s.n.* (MISSA), *Price 52* (MISSA), *Ray 8008* (MISSA), Theriot et al. (1993), *Tracy s.n.* (MISSA)

CONVALLARIACEAE

Maianthemum racemosum (L.) Link, IF, bottomland hardwood forests; *Locke s.n.* (MISSA), *Shelley s.n.* (MISSA), *Stauffer s.n.* (MISSA), Theriot et al. (1993)

Polygonatum biflorum (Walter) Elliott, PR, mesophytic upland hardwood forests, O; *219, 1348 (R219), Bryson 8331, Channell s.n.* (MISSA), *Donald s.n.* (MISSA), *Easley s.n.* (MISSA), *Hammer s.n.* (MISSA), *Morris et al. (1993), Stauffer s.n.* (MISSA)

Uvularia floridana Chapm., **S1**; *Eckles s.n.* (MISSA)

Uvularia grandiflora Sm.; *Easley s.n.* (MISSA)

Uvularia sessilifolia L., IF, bottomland hardwood forests, mesophytic upland hardwood forests, O; *1297, 1367, 1486(R1297)*

CYPERACEAE

Carex abscondita Mack., IF, bottomland hardwood forests; Theriot et al. (1993)

Carex albicans Willd. ex Spreng. var. *albicans*, PR, mesophytic upland hardwood forests, O; Morris et al. (1993)

Carex albicans Willd. ex Spreng. var. *australis* (L.H. Bailey) Rettig, PR, mesophytic upland hardwood forests, O; *66*

Carex albolutescens Schwein., PR, IF, canals/drainage ditches (riparian–banks), roadsides, O; *176, Bryson 3138 (Charles T. Bryson personal herbarium [ctb]), 3191 (ctb), 3833 (ctb)*

Carex annectens (E.P. Bicknell) E.P. Bicknell, PR, IF, bottomland hardwood forests, roadsides, O; *266, Bryson 149*, Morris et al. (1993)

Carex atlantica Bailey ssp. *atlantica*, IF, pine-mixed hardwood forests, seepage areas; *Bryson 3841 (MMNS)*

Carex austrina (Small) Mack., PR, IF; Bryson et al. (1992)

Carex basiantha Steud., BP, PR, mesophytic upland hardwood forests, prairies, O/C(I); *1530, Bryson 3210, 3217, McDaniel 31053*, Morris et al. (1993)

Carex blanda Dewey, BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, O; *191, 1355, Bryson 416, 2880a, 2880b, 3215*, Morris et al. (1993)

Carex brevior (Dewey) Mack. ex Lunell, BP, IF, pine forests, roadsides, O; *225, Bryson 5391, 8600*, Bryson et al. (1992)

Carex bushii Mack., BP, xeric upland hardwood forests, prairie cedar woodlands, C(I); *Bryson 31, McDaniel 10524*

Carex caroliniana Schwein., IF, bottomland hardwood forests, roadsides, A(I); *262, Bryson 92*

Carex cephalophora Muhl. ex Willd., BP, PR, IF, mesophytic upland hardwood forests, xeric upland hardwood forests, pine forests, prairies, rivers/creeks (riparian–banks), urban areas, O/C; *221, Bryson 19, 40, 42, 98, 139, 346, 350, 1337a, 2877, 3214, McDaniel 1818, 2439*, Morris et al. (1993)

Carex cherokeensis Schwein., BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, prairies, prairie cedar woodlands, AA(I); *5, 107, Bryson 5, 6, 13, 16, 20, 26, 27, 34, 126, 352*, Bryson (1980), Leidolf and McDaniel (1998), *McDaniel 1816, Schuster 9*, Morris et al. (1993)

Carex complanata Torr. & Hook., PR, IF, mesophytic upland hardwood forests, pine forests, canals/drainage ditches (riparian–banks), roadsides, C; *237, 240, 1335a, 1476, Bryson 148, 3141*

Carex corrugata Fernald, BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, O; *190, 229, 1520a, Bryson 93 (ctb), 622 (ctb), 3059 (ctb), 3827 (ctb), 5631 (ctb), 5635 (ctb), 5641 (ctb)*

Carex crebriflora Wiegand, IF, bottomland hardwood forests, pine-mixed hardwood forests; *Bryson 675, 3063, 3200, 3656, Rosenkranz s.n.*

Carex crus-corvi Shuttlew. ex Kuntze, IF; *Bryson 288*

Carex debilis Michx., IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine-mixed hardwood forests, O; *1302, Bryson 376, 3139*, Theriot et al. (1993)

Carex digitalis Willd. var. *macropoda* Fernald [= *C. digitalis* Willd.], IF; *Bryson 373 (ctb), 377 (ctb)*

Carex festucacea Schkuhr ex Willd., BP, IF, bottomland hardwood forests, pine forests, canals/drainage ditches (riparian–banks), grass/forb meadows, roadsides, O; Leidolf pers. obs., *Brooks 131, Bryson 282, 366, 3191*

Carex flaccosperma Dewey, BP, IF, bottomland hardwood forests, swamp forests, mesophytic upland hardwood forests, pine forests, canals/drainage ditches (emergent), C; *247, 1295, 1299, 1309, 1478, 1523a, Brooks 127, Bryson 17, 100, 128, 147, 155, 309, 429 (ctb), 964 (ctb), 1853 (ctb), 3060 (ctb), 3071, 3209 (ctb), 3829 (ctb), McDaniel 1675, 2438*, Theriot et al. (1993)

Carex frankii Kunth, BP, PR, IF, bottomland hardwood forests, lakes/ponds/impoundments (littoral–emergent), canals/drainage ditches (emergent), seepage areas, roadsides, C; *384, 575, 1493, 1559, 1571, 1591, Bryson 283, 286*, Morris et al. (1993), *Wigley 314017*

Carex glaucodea Tuck. ex Olney [= *C. flaccosperma* Dewey var. *glaucodea* (Tuck. ex Olney) Kuek.], BP; *Bryson 11671 (ctb)*, Morris et al. (1993)

Carex gracilescens Steud., BP, PR, IF, mesophytic upland hardwood forests, A(I), **S2S3**; *McDaniel 31021*, Morris et al. (1993)

Carex granularis Muhl. ex Willd., BP, prairies, O/C(I); *1529, Bryson 135, McDaniel 31432*, Morris et al. (1993)

Carex hirsutella Mack., BP, IF, prairies; *Brooks 138, McDaniel 11621*

Carex hyalinolepis Steud., IF, canals/drainage ditches (emergent); *Bryson 285, 1860*, Lowe (1921)

Carex intumescens Rudge, IF, bottomland hardwood forests, swamp forests, A(I); *473, 1376, Bryson 90*, Theriot et al. (1993)

Carex jamesii Schwein., BP, PR, mesophytic upland hardwood forests, prairies, R, **S1S2**; *1531, McDaniel 31375*, Morris et al. (1993), Naczi and Bryson (1990)

Carex joorii L.H. Bailey, IF, bottomland hardwood forests, swamp forests, canals/drainage ditches (emergent), O; *912, Bryson 304, 3440*

Carex laevivaginata (KÚk.) Mack., PR, seepage areas; *Bryson 3839 (ctb)*

Carex laxiflora Lam. var. *serrulata* F.J. Herm., PR, mesophytic upland hardwood forests, R, **S1**; *1334a*, Morris et al. (1993)

Carex leavenworthii Dewey, BP, PR, IF, bottomland hardwood forests, roadsides, C; *196, 228*, Morris et al. (1993)

Carex longii Mack., IF, bottomland hardwood forests; *Bryson 153 (ctb), 282 (ctb), 623 (ctb), 707, 2029 (ctb), 3069 (ctb), 3431 (ctb), 7013 (ctb), 8608 (ctb), 8610 (ctb)*

Carex louisianica L.H. Bailey, IF, bottomland hard wood forests, A(I); *456, 910 (R456), 1578 (R456)*

Carex lupulina Muhl. ex Willd., IF, mesophytic upland nardwood forests, O; *558, 1579 (R558)*

Carex lurida Wahlenb., IF, seepage areas, road sides, O; *1479, Bryson 150*

Carex meadii Dewey, BP, PR, prairies, O/C(I), **S3S4**; *1524a, Bryson 44, 59, 415, 1822 (ctb), 3143 (ctb), 3640 (ctb), 3644 (ctb), 3738 (ctb), 3825 (ctb), 4108 (ctb), 5402 (ctb), 11668 (ctb)*, Bryson (1980), Morris et al. (1993), *Tracy 31* (MISSA)

Carex microdonta Torr. & Hook., BP, prairies, O, **S2?**; *1522, Bryson 11667 (ctb)*, Bryson (1980), Bryson et al. (1992)

Carex molesta Mack. ex Bright, BP, PR; Bryson et al. (1992)

Carex muehlenbergii Schkuhr ex Willd., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, prairies, canals/drainage ditches (riparian–banks), O/C(I); *172, 261, Bryson 4409, McDaniel 11620*, Morris et al. (1993)

Carex oxylepis Torr. & Hook. var. *oxylepis*, BP, PR, bottomland hardwood forests, mesophytic upland hardwood forests, prairie cedar woodlands, O; *Bryson 130, 353, 354 (ctb), 2881 (ctb), 3830 (ctb), 5637 (ctb), 5643 (ctb), 5644 (ctb)*

Carex oxylepis Torr. & Hook. var. *pubescens* J.K. Underw., PR; *Bryson 3218 (ctb)*, Bryson et al. (1992)

Carex pigra Naczi, BP, PR; *Bryson 11672 (ctb), 12348 (ctb)*

Carex planispicata Naczi, BP, PR, IF, mesophytic upland hardwood forests, rivers/creeks (riparian–banks), roadsides, O; *222, 1356(R222), Bryson 24, 25, 93, 133, 2879, 3216*

Carex reniformis (L.H. Bailey) Small, IF, bottomland hardwood forests, O/C; *246, McDaniel 1824*

Carex retroflexa Muhl. ex Willd., PR, IF, mesophytic upland hardwood forests, pine forests, O; *192, Bryson 351*

Carex rosea Schkuhr ex Willd., IF; *Bryson 369 (ctb)*

Carex socialis Mohlenbr. & Schwegman, BP, PR, IF, bottomland hardwood forests; *Bryson 966* (MISSA), *5394, Tracy s.n.* (MISSA)

Carex squarrosa L., IF; *Bryson 284*

Carex striatula Michx., PR, mesophytic upland hardwood forests, O; *1301*
Carex stricta Lam., **S2**; Bryson (1980)
Carex styloflexa Buckley, PR, IF, mesophytic upland hardwood forests, pine-mixed hardwood forests, O; *193, Bryson 3055, 3137*
Carex triangularis Boeck., BP, PR, IF, mesophytic upland hardwood forests, xeric upland hardwood forests, pine forests, rivers/creeks (riparian–banks), canals/drainage ditches (riparian–banks), roadsides, O/C; *236, Bryson 23, 38, 39a, 91a, 132a, 156, 1859, 2028, Copeland s.n., McDaniel 1825*
Carex tribuloides Wahlenb., IF, bottomland hardwood forests, rivers/creeks (riparian–banks), canals/drainage ditches (emergent), O; *358, 474, Bryson 676, 3072*, Theriot et al. (1993)
Carex typhina Michx., IF, bottomland hardwood forests, O; *911*
Carex umbellata Schkuhr ex Willd., BP, PR, xeric upland hardwood forests, roadsides, U; *1263, Bryson 5164*, Naczi and Bryson (1990)
Carex vulpinoidea Michx., PR, mesophytic upland hardwood forests, O; Morris et al. (1993)
Cyperus acuminatus Torr. & Hook. ex Torr., BP, canals/drainage ditches (emergent), C; *406, Bryson 10110, MacDonald 10887*
Cyperus compressus L., PR, urban areas, O; *784, Bryson 2605, Copeland s.n., McDaniel 2206*
Cyperus croceus Vahl, IF, pine forests, U; *876a, Bryson 698*
Cyperus echinatus (L.) Wood, IF, grass/forb meadows, roadsides, C; *483, 506, 546, 661, McDaniel 2536, Wigley 314019*
Cyperus erythrorhizos Muhl., IF, lakes/ponds/impoundments (riparian–mudflats), C; *981, Bryson 3439a, 3439b*
**Cyperus esculentus* L., BP, IF, cultivated fields, C; *709, 816, Bryson 3426*
Cyperus flavescens L., PR, urban areas, U; *785*
**Cyperus iria* L., IF, lakes/ponds/impoundments (riparian–mudflats), C; *606, Bryson 345, 3428*, Pullen et al. (1968b), *Wigley 312059*
Cyperus odoratus L., BP, IF, canals/drainage ditches (riparian–banks), urban areas, C; *623, 967, Bryson 3441, Carraway 179, McDaniel 31331*
Cyperus polystachyos Rottb., IF, seepage areas, roadsides, O; *859*
Cyperus pseudovegetus Steud., IF, rivers/creeks (riparian–banks), C; *357, Bruza 980, Bryson 689*
Cyperus retroflexus Buckley, BP, cultivated fields; Bryson and Carter (1992)
Cyperus retrorsus Chapm., IF, grass/forb meadows, O; *662, Bryson 3437*, Lowe (1921)
**Cyperus rotundus* L., BP, IF, seepage areas, cultivated fields, C; *412, 540, 708, Bruza 957, Bryson 2135, 3427, Wigley 313036*
Cyperus strigosus L., IF, canals/drainage ditches (riparian -banks), roadsides, C; *484, 550, Bruza 960, 961, Bryson 701, 3438*, Lowe (1921), *Wigley 315070*
Eleocharis compressa Sull., BP; *Bryson 3146 (ctb)*
Eleocharis elliptica Kunth, BP; *Bryson 1858 (ctb)*
Eleocharis montevidensis Kunth, BP; *Bryson 8920 (ctb)*
Eleocharis obtusa (Willd.) Schult., BP, IF, canals/drainage ditches (emergent), C; *430, 814, 866, Bruza 959, Bryson 685, McDaniel 2539, Wigley 312060*
Eleocharis quadrangulata (Michx.) Roem. & Schult., IF, lakes/ponds/impoundments (littoral–emergent), U; *601, Bruza 982, McDaniel 2550*
Eleocharis smallii Britton, BP; *McDaniel 25026*
Eleocharis tenuis (Willd.) Schult., IF, canals/drainage ditches (emergent), O; *197*
Fimbristylis annua (All.) Roem. & Schult., PR, IF, canals/drainage ditches (emergent), urban areas, O; *783, 862, McDaniel 2727*
Fimbristylis autumnalis (L.) Roem. & Schult., IF, canals/drainage ditches (emergent), O; *860, 863, Bryson 2610, McDaniel 2728*
Fimbristylis decipiens Kral, BP; *MacDonald 10886*
Fimbristylis littoralis Gaudich. [= *F. miliacea* (L.) Vahl], IF, canals/drainage ditches (emergent), O; *864*
Fimbristylis puberula (Michx.) Vahl; *Brooks 151*
Fimbristylis tomentosa Vahl; *Bruza 964*
Kyllinga brevifolia Rottb., PR, urban areas, O; *786, McDaniel 7526*
Kyllinga odorata Vahl, PR, IF, seepage areas, grass/forb meadows, urban areas, C; *546, 846, 965, 1560, Bryson 3434, Carraway 180*
Rhynchospora caduca Elliott, IF, seepage areas, C(I); *491, McDaniel 2547*
Rhynchospora corniculata (Lam.) A. Gray, IF, canals/drainage ditches (emergent), C; *442, Bruza 979*
Rhynchospora globularis (Chapm.) Small; *Brooks 490, Bruza 935, McDaniel 2639*

Rhynchospora glomerata (L.) Vahl, IF, C; *1477*
Rhynchospora inexpansa (Michx.) Vahl, IF, seepage areas, roadsides, C(I); *489, 490 (R489), 492 (R489), 1562*
Scirpus atrovirens Willd., IF, canals/drainage ditches (emergent), roadsides, O; *509*
Scirpus cyperinus (L.) Kunth, IF, lakes/ponds/impoundments (riparian–mudflats, littoral–emergent), O; *583*
Scirpus koilolepis (Steud.) Gleason, IF, urban areas, A(I); *1313*
Scirpus lineatus Michx.; *Carter 3010*
Scirpus pendulus Muhl., BP, canals/drainage ditches (emergent), O; *170*
Scleria oligantha Michx., BP, prairies, R/O; *1521, McDaniel 1087*

DIOSCOREACEAE

Dioscorea villosa L., PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, U; *668*, Jones (1976b), *Phares s.n.* (MISSA), Theriot et al. (1993)

HEMEROCALLIDACEAE

**Hemerocallis fulva* (L.) L., BP, roadsides, urban areas, C; *317*

HYACINTHACEAE

Camassia scilloides (Raf.) Cory, BP, grass/forb meadows, **S2S3**; *Bryson 58, McDaniel 31379*
**Hyacinthoides nonscripta* (L.) Chouard ex Rothm., PR, urban areas, R; *Askew 55*
**Muscari botryoides* (L.) Mill.; *Easley s.n.* (MISSA)
**Muscari neglectum* Guss. ex Ten., PR, roadsides; *Murphy s.n.* (MISSA)

HYDROCHARITACEAE

Limnobium spongia (Bosc) Rich. ex Steud., IF, lakes/ponds/impoundments (littoral–rooted-floating); *Stewart 123*
Najas guadalupensis (Spreng.) Magnus, PR, canals/drainage ditches (submergent), O; *924*
**Najas minor* All., PR, lakes/ponds/impoundments (submergent); Nuttle pers. obs.

HYPOXIDACEAE

Hypoxis hirsuta (L.) Coville, BP, IF, bottomland hardwood forests, mesophytic upland hardwood forests, pine-mixed hardwood forests, prairies, roadsides, O/A(I); *173, 242, Arnett 91* (MISSA), *Channell s.n.* (MISSA), *Locke s.n.* (MISSA), *McDaniel 2414*

IRIDACEAE

**Belamcanda chinensis* (L.) DC., PR, roadsides, U; *Ray 104* (MISSA), *Smith 1444*
Iris virginica L., IF, canals/drainage ditches (emergent), O; *254*
Nemastylis geminiflora Nutt., BP, prairies, chalk outcrops, C(I)/R, **S2**; *1510, McDaniel 31002, Morris 3094*, Morris et al. (1993)
Sisyrinchium albidum Raf., BP, PR, prairies, chalk outcrops, C; *116, 148*, Leidolf and McDaniel (1998), Morris et al. (1993)
Sisyrinchium angustifolium Mill., IF, bottomland hardwood forests, pine forests, O; *250, McDaniel 2440*
Sisyrinchium atlanticum E.P. Bicknell, BP, PR, mesophytic upland hardwood forests, prairies, O; *166, 1330a, McDaniel 31024*
Sisyrinchium mucronatum Michx., IF; *Copeland s.n.*
Sisyrinchium rosulatum E.P. Bicknell, IF, seepage areas, cultivated fields, urban areas, O/C; *499, 1468*

JUNCACEAE

Juncus acuminatus Michx., BP, IF, rivers/creeks (emergent), canals/drainage ditches (emergent), O; *Bryson 1854, McDaniel 25028*
Juncus biflorus Ell., IF, pine-mixed hardwood forests, canals/drainage ditches (emergent), C/A; *362, Bryson 687, McDaniel 2538, 3149*
Juncus brachycarpus Engelm., IF; *Webster 1539*
Juncus bufonius L., BP, PR, cultivated fields, C; *1469, Bryson 3289, 3501*
Juncus coriaceus Mack., IF, canals/drainage ditches (emergent), C; *360, Bryson 1856*
Juncus debilis A. Gray, IF, canals/drainage ditches (emergent), O; *865*
Juncus dichotomus Elliott, IF, canals/drainage ditches (emergent); *Bryson 1855*
Juncus diffusissimus Buckley, IF, canals/drainage ditches (emergent), O; *451*
Juncus effusus L., IF, canals/drainage ditches (emergent), O; *241*
Juncus elliottii Chapm., IF, lakes/ponds/impoundments (riparian–mudflats); *Bryson 686*
Juncus filipendulus Buckley, BP, **S3S4**; *Maddox 1146*
Juncus marginatus Rostk., IF, canals/drainage ditches (emergent), O; *362, McDaniel 2538, 3149*

Juncus nodatus Coville, IF, canals/drainage ditches (emergent), lakes/ponds/impoundments (littoral–emergent), U; *510, 656*

Juncus scirpoides Lam., IF, canals/drainage ditches (emergent); *Bruza 930*

Juncus tenuis Willd., BP, PR, IF, mesophytic upland hardwood forests, xeric upland hardwood forests, pine forests, prairies, rivers/creeks (riparian–banks), canals/drainage ditches (emergent), urban areas, O/C; *378, 476, 1293, Bryson 8, 15, 699, 1682, 2027, Copeland s.n.*, Leidolf and McDaniel (1998)

Juncus torreyi Coville, BP, IF, prairies, canals/drainage ditches (emergent), cultivated fields, grass/forb meadows, C; *288, 383, Bryson 700, 2030, 3994*, Leidolf and McDaniel (1998), *McDaniel 31082*

Juncus validus Coville, IF, bottomland hardwood forests, canals/drainage ditches (emergent), lakes/ponds/impoundments (riparian–mudflats, littoral–emergent), C; *361, Bruza 926, 972, Bryson 727*

Luzula bulbosa (Alph. Wood) Smyth & Smyth, BP, IF, xeric upland hardwood forests, O; *1264, 1318*

Luzula echinata (Small) F.J. Herm., PR, mesophytic upland hardwood forests, O; Morris et al. (1993)

LEMNACEAE

Spirodela polyrrhiza (L.) Schleid., PR, lakes/ponds/impoundments (littoral/profundal–free-floating), A(I); *925*

LILIACEAE

Erythronium albidum Nutt., BP, xeric upland hardwood forests, C(I), **S2**; *McDaniel 10369*

Lilium michauxii Poir., PR, mesophytic upland hardwood forests, R; *Morris 3093*, Morris et al. (1993)

Lilium superbum L., PR, IF, bottomland hardwood forests, RR, **S3S4**; *Leidolf s.n., Phares s.n.*, Theriot et al. (1993)

MELANTHIACEAE

Aletris aurea Walter, IF, pine forests, pine-mixed hardwood forests, seepage areas, roadsides, U/O; *501, 527 (R501), 564, Easley s.n.* (MISSA), *Jordan s.n.* (MISSA), *McDaniel 2638, McKay s.n.* (MISSA), *Ray 4844* (MISSA), *5213* (MISSA)

Aletris farinosa L., IF, pine-mixed hardwood forests; *Ray 6248* (MISSA)

ORCHIDACEAE

Corallorrhiza wisteriana Conrad; Morris pers. obs.

Hexalectris spicata (Walter) Barnhart, PR, mesophytic upland hardwood forests, U; **S2**; *Gordon 2032*

Listera australis Lindl.; McDaniel pers. obs. (specimen extant)

Malaxis unifolia Michx.; McDaniel pers. obs.

Platanthera ciliaris (L.) Lindl., IF, pine forests, pine-mixed hardwood forests, canals/drainage ditches (riparian–banks), R/A(I); *591, Bennett s.n., McDaniel 2637, Ray 4756* (MISSA), *4845* (MISSA), *5215* (MISSA), *Smith 1442*

Platanthera clavellata (Michx.) Luer, IF, pine-mixed hardwood forests; *Ray 4818* (MISSA)

Platanthera cristata (Michx.) Lindl., IF, seepage areas, A(I), **S3**; *526, Ray 5258* (MISSA)

Ponthieva racemosa (Walter) C. Mohr, BP, prairie cedar woodlands, RR, **S2?**; *926*, Leidolf and McDaniel (1998)

Spiranthes cernua (L.) Rich., IF, seepage areas, O; *966*, Morris (1989)

Spiranthes lacera (Raf.) Raf., BP, xeric upland hardwood forests, RR, **S3S4**; *937*

Spiranthes magnicamporum Sheviak, BP, prairies, roadsides, AA(I), **S2S3**; *1002, 1006, 1010, Hare s.n.* (MISSA), Leidolf and McDaniel (1998), Morris (1989), *Ray s.n.* (MISSA)

Spiranthes ovalis Lindl., IF, bottomland hardwood forests, RR, **S2S3**; *970*

Spiranthes praecox (Walter) S. Watson, IF, lakes/ponds/impoundments (riparian–banks), seepage areas, O; *1480*, Morris (1989), *Patts 87* (MISSA), *Tracy s.n.* (MISSA)

Spiranthes tuberosa Raf., IF, pine forests, pine-mixed hardwood forests, U; *876, Ewing s.n.* (MISSA), Morris (1989), *Ray 4848a* (MISSA)

Spiranthes vernalis Engelm. & A. Gray, IF, pine-mixed hardwood forests, lakes/ponds/impoundments (riparian–banks), seepage areas, grass/forb meadows, roadsides, O/C; *321, Hollimon s.n.* (MISSA), *Miles s.n.* (MISSA), Morris (1989), *Ray 6244* (MISSA)

Tipularia discolor (Pursh) Nutt., PR, mesophytic upland hardwood forests, U; *667, 1216 (R667)*

Triphora trianthophora (Sw.) Rydb., IF, bottomland hardwood forests, O/C(I), **S2S3**; *976, Leidolf s.n.*, Theriot et al. (1993)

POACEAE (GRAMINEAE)

Agrostis hiemalis (Walter) Britton, Sterns & Poggenb., IF, seepage areas, cultivated fields, C; *1467*, *1500*, Barkworth et al. (In preparation), *Brooks 134*, Lowe (1921)

Agrostis perennans (Walter) Tuck., BP, IF, bottomland hardwood forests, mesophytic upland hardwood forests, O; *941*, *950*, Lowe (1921), Theriot et al. (1993)

**Aira caryophyllea* L. var. *capillaris* (Host) Mutel [= *A. elegans* Willd. ex Gaudin], IF, roadsides, O; *1484*, *McDaniel 3007*

Alopecurus carolinianus Walter; *Askew 33*, *Bryson 3489*

Andropogon gerardii Vitman, IF, pine forests, C; *918*, Bryson (1980), Lowe (1921)

Andropogon glomeratus (Walter) Britton, Sterns & Poggenb., BP, prairies, C; *995*, Barkworth et al. (In preparation), Leidolf and McDaniel (1998), Lowe (1921), Morris et al. (1993), *Wigley 314108*

Andropogon virginicus L. var. *virginicus*, BP, prairies, C; *1018*, Barkworth et al. (In preparation), Bryson (1980), Leidolf and McDaniel (1998), Lowe (1921), Morris et al. (1993)

Aristida dichotoma Michx.; Barkworth et al. (In preparation), *McDaniel 22200*

Aristida longespica Poir. in Lam. var. *longespica*, BP, prairies, O; *787*, Leidolf and McDaniel (1998), Lowe (1921)

Aristida oligantha Michx., BP, prairies, roadsides, O; *851*, *1599b*, Barkworth et al. (In preparation), *MacDonald 18*

Arundinaria gigantea (Walter) Muhl., PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, A(I); *977*, *1369 (R977)*, Barkworth et al. (In preparation), *Brooks 590*, *Laird 21*, Morris et al. (1993), Theriot et al. (1993)

Axonopus fissifolius (Raddi) Kuhlm. [– *A. affinis* Chase], IF, urban areas, C; *511*, Barkworth et al. (In preparation)

Bothriochloa barbinodis (Lag.) Herter; Barkworth et al. (In preparation)

**Bothriochloa ischaemum* (L.) Keng; Barkworth et al. (In preparation)

Bothriochloa laguroides (DC.) Pilger in Engler ssp. *torreyana* (Steud.) Allred & Gould [= *Andropogon saccharoides* Sw.], BP, prairies, C; *436*, Barkworth et al. (In preparation), Leidolf and McDaniel (1998), Morris et al. (1993), Pullen et al. (1968b), *Wigley 315065*

**Bothriochloa pertusa* (L.) A. Camus [= *Andropogon pertusus* (L.) Willd.], BP, PR, roadsides, O; *1001*, *Allison 8016*, *McDaniel 14669*, Morris et al. (1993), *Stewart 167*, *Wigley 313107*

Bouteloua curtipendula (Michx.) Torr. in Marcy, BP, prairies, A(I), **S3S4**; *616*, Barkworth et al. (In preparation), Bryson (1980), Leidolf and McDaniel (1998), Lowe (1921), Morris et al. (1993)

**Briza minor* L., BP, roadsides, O; *1460*, Barkworth et al. (In preparation)

**Bromus japonicus* Thunb. in Murray, BP, prairies, A(I); *1523*, Barkworth et al. (In preparation), Leidolf and McDaniel (1998)

**Bromus tectorum* L., BP, roadsides, A(I); *1338*, Barkworth et al. (In preparation)

Chasmanthium latifolium (Michx.) H.O. Yates, BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, C; *390*, Barkworth et al. (In preparation), Lowe (1921), Morris et al. (1993), Theriot et al. (1993)

Chasmanthium ornythorhynchum Nees; Barkworth et al. (In preparation)

Chasmanthium sessiliflorum (Poir.) H.O. Yates, IF, bottomland hardwood forests, mesophytic upland hardwood forests, xeric upland hardwood forests, C; *453*, *640*, *1547*, Barkworth et al. (In preparation), *Bruza 965*, *Clonts 541*, Lowe (1921), Theriot et al. (1993)

**Chloris pectinata* Benth.; Barkworth et al. (In preparation)

Cinna arundinacea L., IF, bottomland hardwood forests, lakes/ponds/impoundments (riparian–mudflats), O; *633*, Theriot et al. (1993)

Coelorachis cylindrica (Michx.) Nash, **S1**; Barkworth et al. (In preparation)

**Cynodon dactylon* (L.) Pers., BP, cultivated fields, O; *421*, Barkworth et al. (In preparation), *Bryson 3421*, Lowe (1921)

**Dactylis glomerata* L., BP, prairies, A(I); *1524*, Barkworth et al. (In preparation)

**Dactyloctenium aegyptium* (L.) Willd.; Barkworth et al. (In preparation), Lowe (1921)

Dichanthelium aciculare (Desv. ex Poir. in Lam.) Gould & C.A. Clark ssp. *aciculare*; Barkworth et al. (In preparation)

Dichanthelium aciculare (Desv. ex Poir. in Lam.) Gould & C.A. Clark ssp. *angustifolium* (Elliott)

Freckmann & Lelong in ed.; Barkworth et al. (In preparation)

Dichanthelium aciculare (Desv. ex Poir. in Lam.) Gould & C.A. Clark ssp. *neuranthum* (Griseb.) Freckmann & Lelong in ed., IF, lakes/ponds/impoundments (riparian–mudflats), O; *703*

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark ssp. *fasciculatum* (Torr.) Freckmann & Lelong in ed.; Barkworth et al. (In preparation)

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark ssp. *implicatum* (Scribn.) Freckmann & Lelong in ed., IF, seepage areas, roadsides; *494*

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark ssp. *lindheimeri* (Nash) Freckmann & Lelong in ed., IF, bottomland hardwood forests, pine forests, urban areas, O; *514*; Barkworth et al. (In preparation), *McDaniel 13491*, Theriot et al. (1993)

Dichanthelium boscii (Poir.) Gould & C.A. Clark, PR, IF, mesophytic upland hardwood forests, xeric upland hardwood forests, C; *459*, *639*, Barkworth et al. (In preparation), Morris et al. (1993)

Dichanthelium clandestinum (L.) Gould; Barkworth et al. (In preparation)

Dichanthelium commutatum (Schult.) Gould ssp. *commutatum*; Barkworth et al. (In preparation), Lowe (1921)

Dichanthelium commutatum (Schult.) Gould. ssp. *joorii* (Vasey) Freckmann & Lelong in ed., PR, IF, bottomland hardwood forests, rivers/creeks (riparian–banks), O; *669*

Dichanthelium consanguineum (Kunth) Gould & C.A. Clark, IF, roadsides, O; *861*

Dichanthelium depauperatum (Muhl.) Gould, BP, IF, xeric upland hardwood forests, pine forests, prairies, O; *1358*, *1522a*, Barkworth et al. (In preparation), *McDaniel 1086*, *13490*

Dichanthelium dichotomum (L.) Gould ssp. *dichotomum*; Barkworth et al. (In preparation), Lowe (1921)

Dichanthelium dichotomum (L.) Gould ssp. *microcarpon* (Muhl. ex Elliott) Freckmann & Lelong in ed. [= *P. microcarpon* Muhl. ex Elliott], IF, bottomland hardwood forests, mesophytic upland hardwood forests, O; *455*, Barkworth et al. (In preparation), Theriot et al. (1993)

Dichanthelium dichotomum (L.) Gould ssp. *nitidum* (Lam.) Freckmann & Lelong in ed.; Barkworth et al. (In preparation), Lowe (1921)

Dichanthelium laxiflorum (Lam.) Gould, BP, PR, IF, pine forests, pine-mixed hardwood forests, prairies, roadsides, C; *429*, *592*, *1366a*, Barkworth et al. (In preparation), Lowe (1921), *McDaniel 9798*

Dichanthelium oligosanthes (Schult.) Gould ssp. *oligosanthes*; Barkworth et al. (In preparation)

Dichanthelium oligosanthes (Schult.) Gould ssp. *scribnerianum* (Nash) Freckmann & Lelong in ed., BP, xeric upland hardwood forests, O; Barkworth et al. (In preparation), *McDaniel 1500*

Dichanthelium ovale (Elliott) Gould & C.A. Clark ssp. *villosissimum* (Nash) Freckmann & Lelong in ed.; Barkworth et al. (In preparation)

Dichanthelium polyanthes (Schult.) Mohlenbr., IF, mesophytic upland hardwood forests, canals/drainage ditches (riparian–banks), O; *458*, *572*, Barkworth et al. (In preparation)

Dichanthelium ravenelii (Scribn. & Merr.) Gould, BP, canals/drainage ditches (riparian–banks), O; *171*, Barkworth et al. (In preparation),

Dichanthelium scabriusculum (Elliott) Gould & C.A. Clark, BP, chalk outcrops, urban areas, R/O; Barkworth et al. (In preparation), *McDaniel 22194*, *31045*

Dichanthelium scoparium (Lam.) Gould, IF, grass/forb meadows, C; *493*, Barkworth et al. (In preparation), Lowe (1921)

Dichanthelium sphaerocarpon (Elliott) Gould, IF, canals/drainage ditches (riparian–banks), O; *571*, Barkworth et al. (In preparation), Lowe (1921)

Digitaria ciliaris (Retz.) Koeler var. *ciliaris*, BP, cultivated fields, A(I); *403*, Barkworth et al. (In preparation)

Digitaria filiformis (L.) Koeler; Barkworth et al. (In preparation), *Brooks 492*, Lowe (1921)

**Digitaria ischaemum* (Schreb.) Muhl., BP, prairies, A(I); *994*, Barkworth et al. (In preparation), *Copeland s.n.*, Lowe (1921)

**Digitaria violascens* Link; Barkworth et al. (In preparation)

**Echinochloa colona* (L.) Link, BP, cultivated fields, C; *402*, Barkworth et al. (In preparation), Lowe (1921), *MacDonald 1*, *Wigley 312053*

**Echinochloa crusgalli* (L.) P. Beauv.; Barkworth et al. (In preparation), *Wigley 312054*

**Echinochloa esculenta* (A. Braun) H. Scholtz; Barkworth et al. (In preparation)

**Echinochloa muricata* (P.Beauv.) Fernald, BP, cultivated fields, O; *413*, Barkworth et al. (In preparation)

**Eleusine indica* (L.) Gaertn., BP, roadsides, C(I); *681*, Barkworth et al. (In preparation), *Bryson 3425*, Lowe (1921), *Wigley 313005*

Elymus glabriflorus (Vasey ex L.H. Dewey) Scribn. & C.R. Ball var. *glabriflorus;* Barkworth et al. (In preparation)

Elymus villosus Muhl. var. *villosus*; Barkworth et al. (In preparation)

Elymus virginicus L., BP, PR, IF, bottomland hardwood forests, roadsides, C(I); *385*, *549*, Barkworth et al. (In preparation), Lowe (1921), *MacDonald 24*, Morris et al. (1993)

Eragrostis capillaris (L.) Nees in Mart., BP, prairies, prairie cedar woodlands, C; *795*, *825*, Barkworth et al. (In preparation), Leidolf and McDaniel (1998), *McDaniel 15510, 22168*

Eragrostis frankii C.A. Mey. ex Steud.; Barkworth et al. (In preparation), Lowe (1921)

Eragrostis hirsuta (Michx.) Nees, BP, chalk outrops, R; Barkworth et al. (In preparation), *McDaniel 22931 (MMNS)*

Eragrostis hypnoides (Lam.) Britton, Sterns & Poggenb.; Lowe (1921), *McDaniel 33287*

Eragrostis intermedia Hitchc.; Barkworth et al. (In preparation)

Eragrostis japonica (Thunb.) Trin. [= *E. glomerata* (Walter) L.H. Dewey]; Lowe (1921), *McDaniel 33290, 33296*

Eragrostis pectinacea (Michx.) Nees; Barkworth et al. (In preparation), Lowe (1921)

Eragrostis pilosa (L.) P. Beauv.; Barkworth et al. (In preparation)

Eragrostis refracta (Muhl. ex Elliott) Scribn., IF, lakes/ponds/impoundments (riparian–banks), O; *696*, Barkworth et al. (In preparation), Lowe (1921), *McDaniel 2730*

Eragrostis spectabilis (Pursh) Steud., IF, grass/forb meadows; *633*, Barkworth et al. (In preparation)

Eragrostis trichodes (Nutt.) Alph. Wood; Barkworth et al. (In preparation)

Eriochloa acuminata (J. Presl) Kunth [= *E. gracilis* (E. Fourn.) Hitchc.]; Barkworth et al. (In preparation), *McDaniel 2207*

Eriochloa aristata Vasey; Barkworth et al. (In preparation), Lowe (1921)

**Glyceria declinata* Bréb., IF, grass/forb meadows, U; *1344*, Barkworth et al. (In preparation)

Glyceria striata (Lam.) Hitchc., BP, prairies, O; *1516*, Barkworth et al. (In preparation)

Gymnopogon ambiguus (Michx.) Britton, Sterns & Poggenb.; Barkworth et al. (In preparation), Lowe (1921)

Gymnopogon brevifolius Trin.; Barkworth et al. (In preparation), Lowe (1921), *McDaniel 26518*

Hordeum pusillum Nutt., BP, urban areas, O; *1456*, Barkworth et al. (In preparation), *Bryson 3487*

**Imperata cylindrica* (L.) Raeusch., BP, roadsides, C(I); *1507*, Barkworth et al. (In preparation)

Leersia lenticularis Michx., IF, bottomland hard wood forests, swamp forests, O; *909*

Leersia oryzoides (L.) Sw., IF, bottomland hardwood forests; Barkworth et al. (In preparation), Lowe (1921), *McDaniel 33292*, Theriot et al. (1993)

Leersia virginica Willd., IF, bottomland hardwood forests, rivers/creeks (riparian–banks), O; *689*, Lowe (1921), *MacDonald 23*, Theriot et al. (1993)

Leptochloa panicea (Retz.) Ohwi ssp. *brachiata* (Steud.) N. Snow, BP, canals/drainage ditches (riparian–banks), O; *801*, Barkworth et al. (In preparation)

Leptochloa panicoides (J. Presl) Hitchc., IF, lakes/ponds/impoundments (riparian–banks), A(I); *605*, Barkworth et al. (In preparation)

**Lolium multiflorum* Lam., BP, cultivated fields, C; *414*, Lowe (1921)

Melica mutica Walter, PR, IF, mesophytic upland hardwood forests, O; *1300*, *1310*, Barkworth et al. (In preparation), Lowe (1921)

**Miscanthus sinensis* Andersson, Barkworth et al. (In preparation), *Mathies 864*

Muhlenbergia glabriflora Scribn., IF, bottomland hardwood forests, canals/drainage ditches (riparian–banks), U **S?**; *Leidolf s.n.*, Theriot et al. (1993)

Nassella leucotricha (Trin. & Rupr.) R.W. Pohl; Barkworth et al. (In preparation)

Nassella viridula (Trin.) Barkworth; Barkworth et al. (In preparation)

Panicum anceps Michx. ssp. *anceps*, IF, mesophytic upland hardwood forests, O; *454*, *552 (R454)*, Barkworth et al. (In preparation)

Panicum capillare L. ssp. *capillare*, BP, cultivated

fields, roadsides, C; *411*, *629*, Barkworth et al. (In preparation)

Panicum dichotomiflorum Michx. ssp. *dichotomiflorum*, BP, roadsides, O; *892*, Barkworth et al. (In preparation)

Panicum flexile (Gatt.) Scribn. in Kearney, BP, prairie cedar woodlands, O; *826*, Barkworth et al. (In preparation), Lowe (1921)

Panicum rigidulum Bosc ex Nees in Mart. ssp. *pubescens* (Vasey) Freckmann & Lelong in ed., IF, bottomland hardwood forests, lakes/ponds/impoundments (riparian–banks), A(I); *602*

Panicum rigidulum Bosc ex Nees in Mart. ssp. *rigidulum*; Barkworth et al. (In preparation), Lowe (1921)

Panicum verrucosum Muhl.; Barkworth et al. (In preparation), Lowe (1921), *McDaniel 33288*

Panicum virgatum L., BP, IF, prairies, seepage areas, C; *590*, *617*, Barkworth et al. (In preparation), Leidolf and McDaniel (1998), Lowe (1921)

Paspalum bifidum (A. Bertol.) Nash; Barkworth et al. (In preparation), Lowe (1921)

Paspalum boscianum Flüggé; Barkworth et al. (In preparation), Lowe (1921), *Wigley 312056*

Paspalum conjugatum P.J. Bergius; Barkworth et al. (In preparation)

**Paspalum dilatatum* Poir. in Lam., BP, prairies, cultivated fields, C; *382*, *419*, Barkworth et al. (In preparation), *MacDonald 16*

Paspalum distichum L., IF, lakes/ponds/impoundments (riparian–mudflats), U; *632*, Barkworth et al. (In preparation), Lowe (1921)

Paspalum floridanum Michx., BP, IF, prairies, seepage areas, roadsides, C; *488*, Barkworth et al. (In preparation), *Carraway 177*, *Clonts 1401*, Leidolf and McDaniel (1998), Lowe (1921)

Paspalum laeve Michx., IF, seepage areas, roadsides, C; *487*, Barkworth et al. (In preparation), Lowe (1921), *McDaniel 2729*

**Paspalum notatum* Flüggé, BP, roadsides, C; *401*, Barkworth et al. (In preparation), *Wigley 314024*

Paspalum paniculatum L.; Barkworth et al. (In preparation)

Paspalum praecox Walter; Barkworth et al. (In preparation), Lowe (1921)

Paspalum pubiflorum Rupr. ex E. Fourn., BP, cultivated fields, U; *818*, Barkworth et al. (In preparation), *McDaniel 2265*

**Paspalum racemosum* Lam.; Barkworth et al. (In preparation)

Paspalum repens P.J. Bergius, IF, bottomland hardwood forests, rivers/creeks (riparian–banks), O; Barkworth et al. (In preparation), *Leidolf s.n.*, *McDaniel 33289*, *33293*, Theriot et al. (1993)

Paspalum setaceum Michx. var. *ciliatifolium* (Michx.) Vasey; Barkworth et al. (In preparation)

**Paspalum urvillei* Steud., IF, seepage areas, road sides, C; *486*, Barkworth et al. (In preparation), *Brooks 476*, *Webster 277*, *Wigley 314026*

**Pennisetum ciliare* (L.) Link; Barkworth et al. (In preparation)

**Pennisetum setigerum* (Vahl) Wipff; Barkworth et al. (In preparation)

Phalaris caroliniana Walter, BP, prairies, O; *1364*, *Brooks 126*, *Wigley 313006*

**Phyllostachys aureosulcata* McClure; *MacDonald 1368*

**Phyllostachys flexuosa* Rivière & C. Rivière, IF, lakes/ponds/impoundments (riparian–banks), A(I); *869*, *MacDonald 1369*

**Phyllostachys meyeri* McClure, PR, IF, lakes/ponds/impoundments (riparian–banks), roadsides, A(I); *723*, *845*, *MacDonald 1371*

**Poa annua* L., BP, cultivated fields, urban areas, C; *1265*, *1280*, Barkworth et al. (In preparation), *Bryson 349*, Lowe (1921)

Poa arachnifera Torr.; Barkworth et al. (In preparation), Lowe (1921)

Poa autumnalis Muhl. ex Elliott, PR, mesophytic upland hardwood forests, C; *1336a*, *1354*, Barkworth et al. (In preparation), Lowe (1921)

Poa chapmaniana Scribn.; Barkworth et al. (In preparation), Lowe (1921)

**Poa pratensis* L., PR, urban areas, C; Leidolf pers. obs., Lowe (1921)

Saccharum brevibarbe (Michx.) Pers. var. *brevibarbe*; Barkworth et al. (In preparation), Lowe (1921)

Saccharum brevibarbe (Michx.) Pers. var. *contortum* (Elliott) R.D. Webster [= *Erianthus contortus* Elliott], IF, pine forests, C; *988*, Lowe (1921)

Saccharum giganteum (Walter) Pers. [= *Erianthus giganteus* (Walter) F.T. Hubb.], IF, pine forests, C; *916*, Barkworth et al. (In preparation), Lowe (1921)

**Schedonorus arundinaceus* (Schreber) Dumort.

[= *Lolium arundinaceum* (Schreber) Darbysh., *Festuca elatior* L.]–BP, PR, bottomland hardwood forests, cultivated fields, O; *418*, Morris et al. (1993)

Schizachyrium scoparium (Michx.) Nash in Small var. *scoparium*, BP, IF, pine forests, prairies, C; *917*, Barkworth et al. (In preparation), Leidolf and McDaniel (1998)

**Setaria faberi* R.A.W. Herrm. in F. Rosen, BP, cultivated fields, O; *898*

Setaria parviflora (Poir.) Kerguélen [= *S. geniculata auct. non* Willd.], BP, IF, prairies, roadsides, C; *386*, *543*, Barkworth et al. (In preparation), Leidolf and McDaniel (1998)

**Setaria pumila* (Poir.) Roem. & Schult. ssp. *pumila* [= *S. glauca* (L.) P. Beauv.], IF, roadsides, C; *542*, Barkworth et al. (In preparation)

Sorghastrum nutans (L.) Nash in Small, IF, pine forests, O; *987*, Barkworth et al. (In preparation)

**Sorghum* × *almum* Parodi, BP, cultivated fields, U; *817*, Barkworth et al. (In preparation)

**Sorghum halepense* (L.) Pers., BP, PR, bottomland hardwood forests, prairies, cultivated fields, roadsides, A; *380*, *420*, Barkworth et al. (In preparation), *MacDonald 9*, Morris et al. (1993), *Wigley 313063*

Sphenopholis intermedia (Rydb.) Rydb., IF, bottomland hardwood forests, O; *1375*

Sphenopholis obtusata (Michx.) Scribn., PR, urban areas, O; *1324a*, Lowe (1921), *McDaniel 1830*

Sporobolus clandestinus (Biehler) Hitchc.; Barkworth et al. (In preparation)

Sporobolus compositus (Poir.) Merr. var. *compositus* [– *S. asper* (Michx.) Kunth]; Lowe (1921), *McDaniel 22169*

Sporobolus compositus (Poir.) Merr. var. *drummondii* (Trin.) Kartesz & Gandhi; Barkworth et al. (In preparation)

Sporobolus compositus (Poir.) Merr. var. *macer* (Trin.) Kartesz & Gandhi; Barkworth et al. (In preparation)

Sporobolus cryptandrus (Torr.) A. Gray; Barkworth et al. (In preparation), Lowe (1921)

**Sporobolus indicus* (L.) R. Br. [= *S. poiretii* (Roem. & Schult.) Hitchc.], BP, IF, xeric upland hardwood forests, prairies, C; *618*, *1548*, Barkworth et al. (In preparation), Leidolf and McDaniel (1998), Lowe (1921)

Sporobolus vaginiflorus (Torr. ex A. Gray) Alph. Wood, BP, prairies, O; *1017*, Barkworth et al. (In preparation), Leidolf and McDaniel (1998), Lowe (1921), *McDaniel 31318*, *31320*

Steinchisma hians (Elliott) Nash in Small, IF, urban areas, O; *513*, Barkworth et al. (In preparation)

Tridens flavus (L.) Hitchc. var. *flavus*, PR, IF, bottomland hardwood forests, roadsides, C; *541*, Barkworth et al. (In preparation), *Copeland s.n.*, Lowe (1921), Morris et al. (1993), *Wigley 314022*

Tridens strictus (Nutt.) Nash in Small, IF, roadsides, C; *568*, Barkworth et al. (In preparation), *Copeland s.n.*, Lowe (1921), *Wigley 312057*

Tripsacum dactyloides (L.) L., IF, roadsides, O; *548*, Barkworth et al. (In preparation), *Carraway 181*, Lowe (1921), *Snow 66*

**Trisetum flavescens* (L.) P. Beauv.; Barkworth et al. (In preparation)

Urochloa platyphylla (Munro ex Wright) R.D. Webster [= *Brachiaria platyphylla* (Griseb.) Nash in Small], BP, cultivated fields, A(I); *891*, Barkworth et al. (In preparation), *Wigley 312052*

Urochloa ramosa (L.) T.Q. Nguyen [= *Panicum ramosum* L.], PR, IF, canals/drainage ditches (riparian–banks), roadsides, urban areas, O/A(I); *567*, Barkworth et al. (In preparation), *McDaniel 2204*

Urochloa texana (Buckley) R.D. Webster; Barkworth et al. (In preparation)

Vulpia octoflora (Walter) Rydb. var. *octoflora* [= *Festuca octoflora* Walter]; *Brooks s.n.*, Lowe (1921)

POTAMOGETONACEAE

Potamogeton diversifolius Raf., lakes/ponds/impoundments (littoral–rooted-floating); *Channell s.n.* (MISSA), Jones (1974a), *McDaniel pers. obs.* (specimen extant)

Potamogeton nodosus Poir., IF, lakes/ponds/impoundments (littoral -rooted-floating), C(I); *Bruza 983*

SMILACACEAE

Smilax bona-nox L., BP, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, prairie cedar woodlands, chalk outcrops, O/C; *Easley s.n.* (MISSA), *Leidolf s.n.*,

Leidolf and McDaniel (1998), Lowe (1921), Morris et al. (1993), *Ray 100* (MISSA), *6749* (MISSA), Theriot et al. (1993), *Tracy s.n.* (MISSA)

Smilax glauca Walter, IF, bottomland hardwood forests, pine-mixed hardwood forests, C; Lowe (1921), *Ray 6781* (MISSA), Theriot et al. (1993)

Smilax lasioneura Hook., BP, PR, mesophytic upland hardwood forests, xeric upland hardwood forests, C; *Easley s.n.* (MISSA), *Morris 3092*, *Persons s.n.* (MISSA), *Ray 6722* (MISSA), *8059* (MISSA)

Smilax pulverulenta Michx., PR, mesophytic upland hardwood forests, O; *220*, *Easley s.n.* (MISSA), Lowe (1921), *McDaniel 28154*, Morris et al. (1993)

Smilax rotundifolia L., BP, PR, IF, bottomland hardwood forests, pine forests, pine-mixed hardwood forests, prairies, C; *232*, *1320*, *Askew 62*, *68*, Leidolf and McDaniel (1998), Lowe (1921), *McDaniel 1676*, *31028*, Morris et al. (1993), *Price s.n.* (MISSA), Theriot et al. (1993)

Smilax smallii Morong, IF, bottomland hardwood forests; *Leidolf s.n.*, Theriot et al. (1993)

Smilax tamnoides L., BP, IF, bottomland nardwood forests; *Ray 100* (MISSA), Theriot et al. (1993)

TRILLIACEAE

Trillium cuneatum Raf., IF, bottomland hardwood forests; *Blocker s.n.* (MISSA)

Trillium recurvatum L.C. Beck, PR, IF, bottomland hardwood forests, mesophytic upland hardwood forests, R/C; *96*, *149 (R96)*, *1261 (R96)*, *Channell s.n.* (MISSA), *Easley s.n.* (MISSA), *Fletcher s.n.* (MISSA), Morris et al. (1993), *Persons s.n.* (MISSA), *Smith 1935*

TYPHACEAE

**Typha angustifolia* L., BP, canals/drainage ditches (emergent), A(I); *McDaniel 31081*

Typha latifolia L., BP, IF, canals/drainage ditches (emergent), A(I); *315*, *603*, *1569*

XYRIDACEAE

Xyris torta Small, IF, pine forests, canals/drainage ditches (emergent), seepage areas, R/U; *480*, *525*, *1558*, *McDaniel 2640*, *Smith 1443*

ZANNICHELLIACEAE

Zannichellia palustris L., IF, lakes/ponds/impoundments (littoral–submergent); Jones (1974a), *Ray s.n.* (MISSA)

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Book Review

Richard Dwight Porcher and Douglas Alan Rayner. 2001. **A Guide to the Wildflowers of South Carolina.** (ISBN 1-57003-437-0, hbk.). University of South Carolina, 718 Devine Street, Columbia, SC 29208, U.S.A. (Orders: 800-768-2500, 800-768-0740 fax). $49.95, 551 pp, 11 figures, numerous color photos, 7" × 10 1/4".

This book is near the top of the 'must-have' list for anyone interested in plants and plant communities of the eastern United States. The range of subject matter is far broader than implied by the title—so much so that one has to wonder at the title selection. The wildflower photos and brief accompanying descriptions (about 700 species) occupy a little more than half of the 551 total pages—the remainder provides a wealth of information on aspects of botany and plant communities in South Carolina. The book could easily serve as the primary basis for courses in plant taxonomy, plant communities, or related topics, especially as supplemented by "Natural Vegetation of South Carolina" (J.M. Barry 1980) and "Wildflowers of the Carolina Low Country and Lower Pee Dee" (Porcher 1995).

With this nearly unmitigated commendation in introduction, an outline of the chapters conveys a quick overview:

- Introduction
- Natural History of Selected Groups of Vascular Plants (including carnivorous plants, native orchids, poisonous plants, woody vines, epiphytic, saprophytic, and parasitic plants, medicinal plants and folk remedies, edible wild plants, naturalized plants, and duckweeds)
- History of Field Botany in South Carolina
- Selected Topics on Natural History and Ecology (including 'Succession in Natural Communities,' Fire in the South Carolina Landscape, Carolina Bays of the Coastal Plain, 'Reproductive Strategies of Vascular Plants,' 'Economic and Cultural Notes,' 'Longleaf Pine and the Naval Stores Industry,' 'Agriculture and Forestry: Effects on South Carolina's Physical Landscape,' and 'Marshes, Swamps, Peatlands, Bogs, and Fens'
- South Carolina's Natural Wildflower Communities (The Mountains, The Piedmont, The Fall-Line Sandhills, The Coastal Plain, The Maritime Strand; numerous subdivisions in each category)
- Species Descriptions and Color Plates (divided into the same 'natural communities' and numerous subdivivisions to match the preceding chapter, with the addition of 'The Ruderal Communities')
- Field Guide to Natural Plant Communities (also divided first by community type, then by county – then, for those wanting to walk through the real thing, various natural area preserves, State Parks, and National Forests are identified and discussed under individual counties)
- Indices and other "end" pieces (including keys to selected plant groups, a guide to South Carolina herbaria, references, common and scientific names, and a "general index")

I register only a single objection—if one is trying to match a plant in hand with a photo in the book, an inordinate amount of page-flipping may be required. The photographs and brief notes on individual species are arranged first by community and then by some other criterion that is not clear to me. Even within one community, species of a single family are not grouped together. This objection, however, must show a personal bias of mine, because other recent books (including the earlier S.C. volume by Porcher, noted above) are published with the same format, the much-experienced authors (Porcher & Rayner) explicitly intend the book to be a field guide, and apparently inexperienced students find the arrangement useful.—*Guy L. Nesom, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX, 76102-4060, U.S.A.*

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ENDEMISM IN THE WEST GULF COASTAL PLAIN: IMPORTANCE OF XERIC HABITATS

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ABSTRACT

We studied the relationship between West Gulf Coastal Plain plant endemics and habitat. Approximately half of all West Gulf Coastal Plain endemics are associates of one habitat: xeric sandylands. We discuss some implications of these data to age and former extent of xeric sandylands in the region, notably isolation of the West Gulf Coastal Plain from the East Gulf Coastal Plain and a long and distinctive biotic history.

KEY WORDS: West Gulf Coastal Plain, endemic plants, grossarenic dry uplands, xeric sandylands.

RESUMEN

Se han estudiado las relaciones entre las plantas endémicas y el hábitat de la llanura costera del Golfo Oeste. Aproximadamente la mitad de los endemismo están asociados a un hábitat: terrenos arenosos xéricos. Se discuten algunas implicaciones de estos datos con la edad y extensión anterior de los terrenos arenosos xéricos en la región, notablemente aislamiento de la llanura costera del Golfo Oeste de la llanura costera del Golfo Este y una historia biótica larga y diferente.

INTRODUCTION

The Atlantic and Gulf Coastal plains have been recognized as a floristic province of distinction in part due to the high number of endemic and near-endemic species (Takhtajan 1986). In North America, the Atlantic and Gulf Coastal floristic province is second only to the California floristic province in endemics; approximately 27 percent of its native species are endemic or near endemic to it while in the latter province 48% are endemic or near endemic (Sorrie & Weakley 2001). While important local centers of endemism, such as the Apalachicola and Lake Wales regions of Florida, are well known, the significance of the West Gulf Coastal Plain (WGCP) has received almost no attention in the published literature or has been portrayed as largely depauperate in

endemics (Ricketts et al. 1999). That the WGCP constitutes a regional center of endemism has been only recently demonstrated (Estill & Cruzan 2001; Sorrie & Weakley 2001). In this paper, based on a list of endemics from the WGCP and their habitat affiliation, we begin a dialogue about evolutionary origin, divergence, and migration for the region.

The WGCP center of endemism encompasses most of eastern Texas and western Louisiana, southern Arkansas, and southeastern Oklahoma (Fig. 1). Its western margin is not clearly defined, either geologically or botanically (Fennemen 1938; Christensen 2000). Its eastern boundary is the Mississippi River floodplain. Our definition is approximately the same as that of Sorrie and Weakley (2001) except that we encompass slightly more of south-central Texas because the east Texas flora clearly extends into those counties just east of Austin and San Antonio (Region 3 of Hatch et al. 1990). Although within the geological coastal plain, the gulf prairies and marshes (Region 2 of Hatch et al. 1990) are excluded because it appears that this region is a separate center of endemism (Sorrie & Weakley 2001), which itself needs detailed study.

METHODS

To develop a list of endemics, we obtained species distributional data from a wide variety of sources, including regional, state and local floras, floristic atlases, published papers, and monographs (among which are Correll & Johnston 1970; Jones 1977; MacRoberts 1984, 1989; Poole & Riskind 1987; Smith 1988; Bridges & Orzell 1989; Taylor & Taylor 1989; Hatch et al. 1990; Isely 1990; Nixon & Kell 1993; Texas Organization for Endangered Species 1993; Thomas & Allen 1993–1998; Walker 1993; Texas Natural Heritage Program 1995a; Turner 1996; Nesom 1997; Diggs et al. 1999; Kartesz & Meacham 1999; Louisiana Natural Heritage Program 1999; Turner in press; and several web sites centering on the Flora of Texas Consortium), Natural Heritage Program databases, our own field work, and an examination of herbarium specimens, notably at ASTC, BRIT, Corpus Christi Museum of Science and History, GH, LSU, LSUS, NCU, NLU, SBSC, SHST, TAMU (on line), TEX, VDB, and WWF. The list was begun independently of Sorrie and Weakley (2001) and has continued to develop after their list appeared.

We consider those species to be endemic whose occurrence is limited to the WGCP; near-endemic refers to species that are at least 90 percent centered on the WGCP. These species are listed in Appendix 1.

We encountered two major problems in developing the list. First, distributional information is incomplete in many cases. Various state and regional distribution maps and descriptions are either incomplete or do not agree. Second, taxonomic difficulties are frequent: for example, should *Trillium texanum* Buckley be considered a species, a subspecies, or a distinct taxon at all? We simply have followed the predominant view where possible (e.g., Jones et al. 1997;

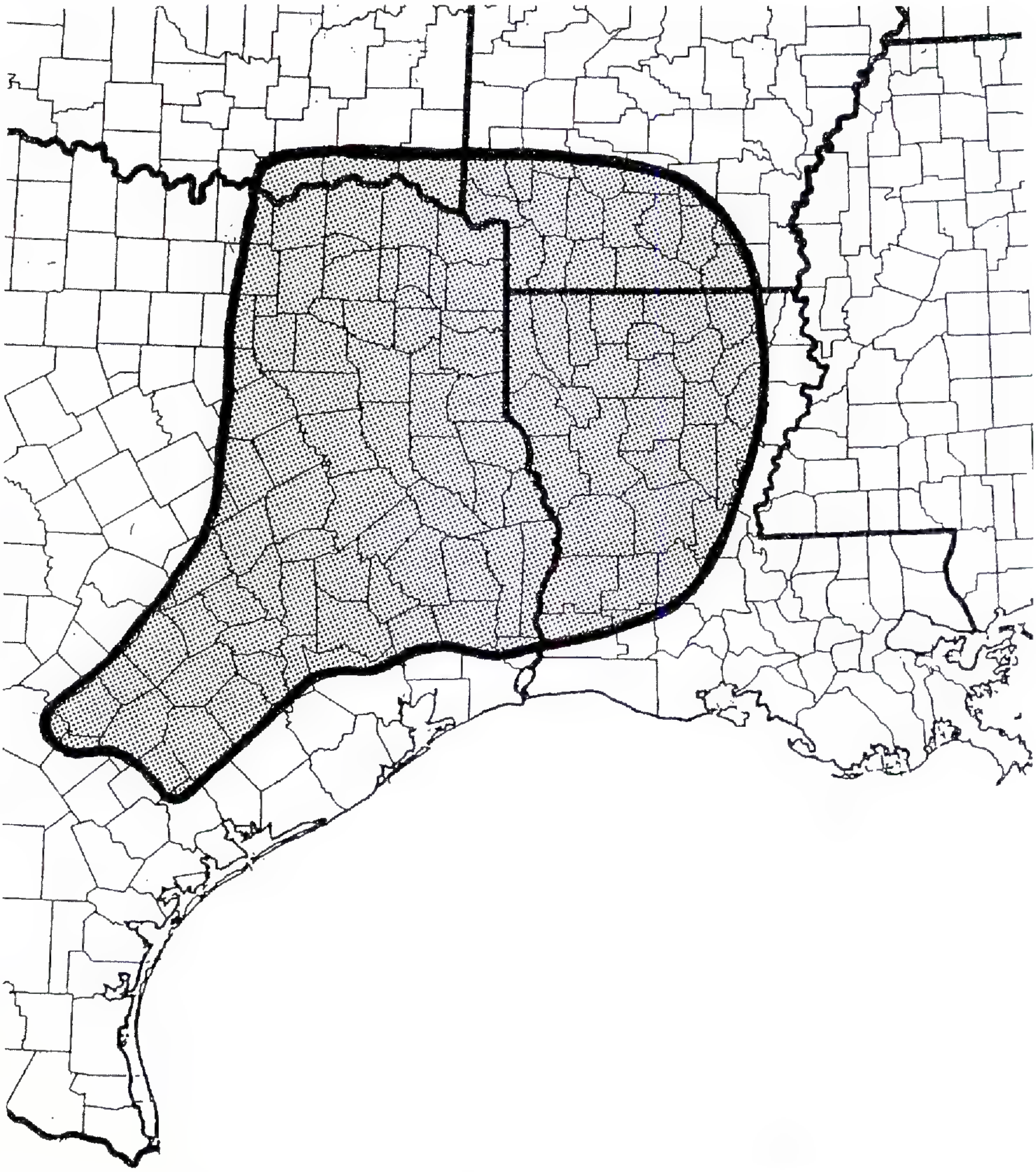


FIG. 1. Map showing West Gulf Coastal Plain.

Kartesz & Meacham 1999). We have developed a fairly conservative list, which we will continue to update and refine in future.

After we had developed the endemic/near-endemic list (which, for the sake of brevity, will be referred to hereafter as "endemics"), we attempted to determine for each taxon its community association (habitat) in the WGCP. We examined all major classifications (Diamond et al. 1987; Texas Organization for Endangered Species 1992; Harcombe et al. 1993; Foti et al. 1994; Texas Natural Heritage Program 1995b; Louisiana Natural Heritage Program 1998; Turner et.

al. 1999; Van Kley 1999a, 1999b; Weakley et al. 1999; Hoagland et al. 2000). We selected the Turner et al. (1999; see also Van Kley 1999a, 1999b) classification because it is based on quantitative data and is manageable and applicable over a wide geographic area. With a few modifications, it is presented in Appendix 2 with associated plant group in parentheses and with The Nature Conservancy (TNC) "ecological group" designations in brackets (Weakley et al. 1999). We then assigned each endemic to habitat of best fit on the basis of the literature, personal experience, and herbarium labels. It was not always possible to determine community type, a few taxa were assigned to two types, and a few were left blank.

RESULTS

Table 1 presents number and percent of WGCP endemics associated with each community. Of the 96 taxa in our endemic list, we were able to classify all but three to one or more communities. Number 1, xeric sandylands, proved to have by far the most endemics. Of the 96 endemics, 53 percent are associated with xeric sandylands. The communities with the next highest number of endemics are barrens, glades and weches, and bogs and wet pine savannas, each with nine percent of the total.

TABLE 1. Plant communities and number and percent of WGCP endemics associated with each.

Community	Number	Percent
1 Xeric sandylands	51	53
2 Upland pine savanna, mixed woods	4	4
3 Loamy dry-mesic uplands	0	0
4 Bogs, wet pine savannas	9	9
5 Calcareous forest	0.5	1
6 Mayhaw pond	2	2
7 Barrens, glades, weches barrens	9	9
8 Beech slopes	1	1
9 Stream course	1.5	2
10 Baygall	3.5	4
11 Bottomland, floodplain	6	6
12 Ponds, marshes	0	0
13 Prairies	5.5	6
Unknown	3	3
Total	**96**	**100**

DISCUSSION

Xeric sandylands have the most endemics, a fact recognized by Bridges and Orzell (1987, 1989) some years ago. Of the three genera endemic to the WGCP, *Maclura*, *Brazoria*, and *Rhododon*, two, *Brazoria* and *Rhododon*, are associated with xeric sandylands (Turner 1995, 1996). Xeric sandylands are open to sparsely

wooded areas that typically occur on terraces or ridges composed of deep sand, generally of marine Tertiary origin (McBryde 1933; Bridges & Orzell 1989; Harcombe et al. 1993; MacRoberts & MacRoberts 1994, 1995, 1996; MacRoberts et al. 2002; Turner et al. 1999). Water and air move rapidly through these soils. Soils, where undisturbed, are often cryptogamic. Foliose lichens (*Cladonia* spp.) may be common. Stunted *Quercus stellata* Wangenh., *Q. margarettiae* Ashe ex Small, *Q. incana* W. Bartram, and various *Carya* species are dominant trees in xeric sandylands. Other characteristic species are *Bulbostylis ciliatifolia* (Elliott) Fernald, *Cnidoscolus texanus* (Muell.-Arg.) Small, *Croton argyranthemus* Michx., *Cyperus grayioides* Mohlenbrock, *Eriogonum longifolium* Nutt., *E. multiflorum* Benth., *Froelichia floridana* (Nutt.) Moq., *Hymenopappus artemisiifolius* DC., *Matelea cynanchoides* (Engelm.) Woodson, *Mirabilis albida* (Walter) Heimrl, *Opuntia humifusa* (Raf.) Raf., *Paronychia drummondii* Torr. & A. Gray, *Pediomelum digitatum* (Nutt. ex Torr. & A. Gray) Isely, *P. hypogaeum* (Nutt. ex Torr. & A. Gray) Rydb. var. *subulatum* (Bush) J.W. Grimes, *Phlox drummondii* Hook., *Polygonella americana* (Fisch. & C.A. Mey.) Small, *P. polygama* (Vent.) Engelm. & A. Gray, *Selaginella arenicola* Underwood subsp. *riddellii* (Van Eselt.) R.M. Tryon, *Streptanthes hyacinthoides* Hook., *Talinum rugospermum* Holz., *Tetragonotheca ludoviciana* (Torr. & A. Gray) A. Gray ex Hall, *Thelesperma filifolium* (Hook.) A. Gray, *Tradescantia reverchonii* Bush, *Tragia* spp., *Yucca louisianensis* Trel., and *Zornia bracteata* J.F. Gmel.

Sorrie and Weakley (2001) identify the Carrizo Sands of Texas as one endemic center for the Atlantic and Gulf Coastal plains (see McBryde 1933 for a description of this area). While the Carrizo Formation is a narrow band running from the Rio Grande to northeastern Texas and then southward to eastern Texas and has xeric sandylands scattered throughout, xeric sandylands are not confined to this formation but occur virtually throughout the WGCP in both pineywoods and post oak savanna in Oklahoma, Arkansas, Louisiana, and Texas as shown by the distribution of species fidel to this community as discussed by MacRoberts et al. (2002). In that study, in order to develop an objective idea of the distribution of xeric sandylands, we chose 42 fidel species from the total list of species occurring in this community and mapped these by county and parish over their ranges (Fig. 2) (see also McBryde 1933; Drawe et al. 1978; Ajilvsgi 1979; Marietta & Nixon 1983; Matos & Rudolph 1985; Bridges & Orzell 1989; Ward & Nixon 1992; Harcombe et al. 1993; MacRoberts & MacRoberts 1994, 1995, 1996; Hoagland 2000).

While widespread, xeric sandylands are not a dominant community across the WGCP but are generally found in relatively small patches. At the time of European settlement it has been estimated that xeric sandylands accounted for less than one percent of western Louisiana (Louisiana Natural Heritage Program 1993) and, although there are no published figures, probably no more than this in either Oklahoma or Arkansas. In Texas, especially along the Carrizo for-

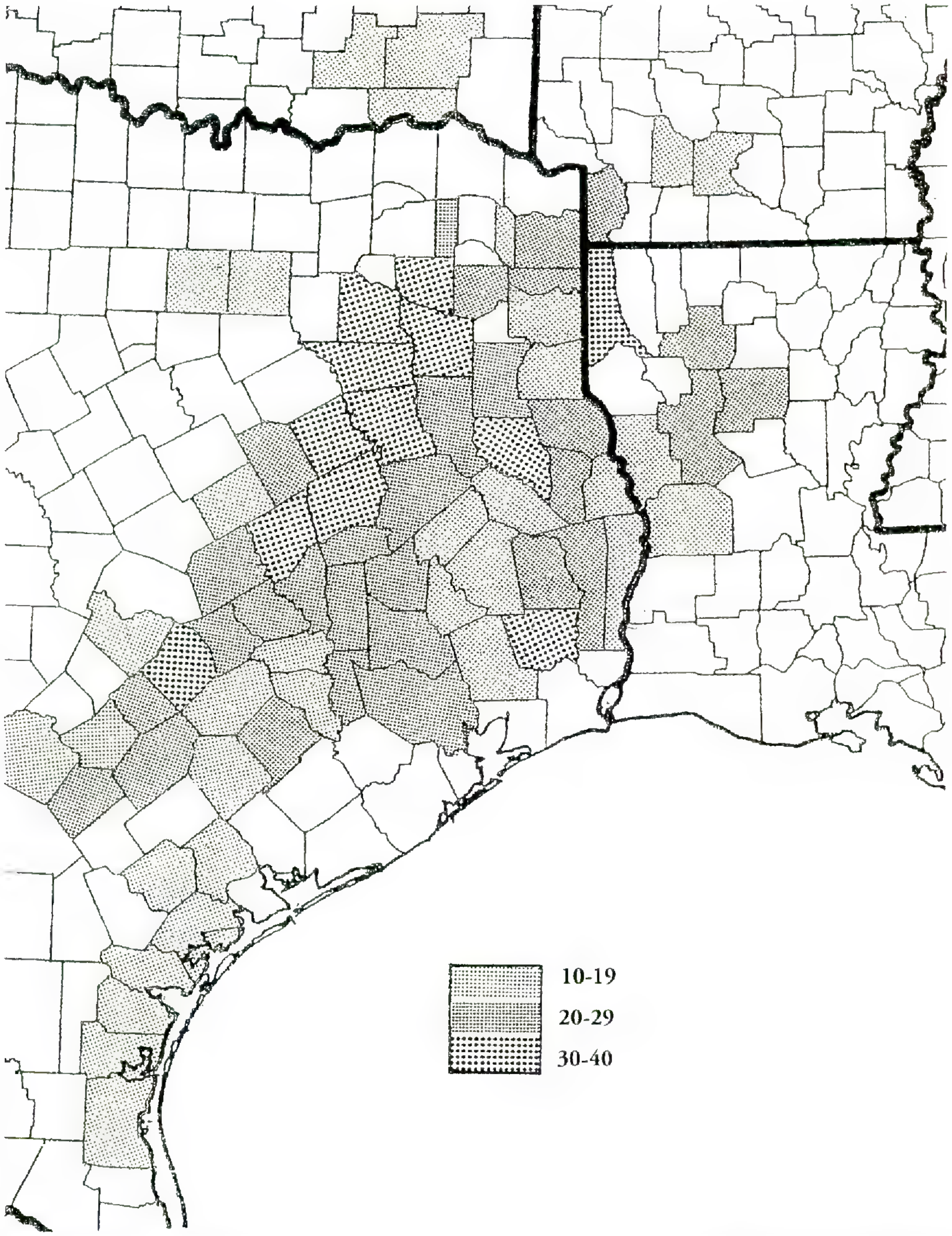


FIG. 2. Xeric sandyland species distribution. Key = number of species in sample list of 42 species located in each county either by personal inspection, herbarium searches, or literature (see MacRoberts et al. 2002 for further explanation).

mation (McBryde 1933), xeric sandylands were common, but for the whole of the region this community is unlikely to have amounted to more than five percent of the area.

While there appears to be disagreement among palynologists concerning

short-term climatic events in the southeast in general and the WGCP in particular during glacial and post-glacial times as to whether or not there were south Texas and Mexican refugia (Martin & Harrell 1957; Ellis et al. 1995; Schmidtling & Hipkins 1998), the major long-term patterns are relatively clear (Bryant 1977; Watts 1980; Bryant & Holloway 1985; Webb 1988; Webb et al. 1993; Delcourt et al. 1993; Delcourt & Delcourt 1993, 2000; Bousman 1998). The picture that emerges supports the thesis presented here: xeric sandylands (open post-oak savannas and woodlands on sandy soils) were present as a community type within the WGCP since the last glaciation. We know that coarse sands necessary for the physical development of xeric habitats were present since the Eocene (McBryde 1933; Sorrie & Weakley 2001 and references therein). Prone to frequent water deficits and nutrient limitations, these soils undoubtedly have always dramatically affected vegetation structure and composition, which probably explains why percent sand present in surface soils of the Coastal Plain is a key determinant of vegetation patterns throughout this area (McBryde 1933; Harcombe et al. 1993; Peet & Allard 1993; Christensen 2000). We also know from pollen counts from dozens of bogs along the western edge of the WGCP (unfortunately the only area of east Texas with lengthy pollen records) that oaks and grasses dominated after the last glaciation (Bryant 1977; Bryant & Holloway 1985; Holloway et al. 1987). The prehistoric landscape that is revealed is one that is not dissimilar to that seen in the region today: oak-dominated sandy "savannas" and hilltops that act as reservoirs for water that feeds the adjacent seeps, marshes, streams, and peat bogs of the area (McBryde 1993; MacRoberts & MacRoberts 1998, MacRoberts et al. 2002). Unfortunately, palynology is seldom precise to species; our hypothesis would be that oaks were probably those of dryer habitat: *Quercus stellata* and *Q. incana*, and that the herbaceous vegetation included, in part, the evolving endemics described here. After all, the peat bog habitats that contain the continuous pollen profiles extending back thousands of years still exist (see MacRoberts & MacRoberts 1998; Potzger & Tharp 1947; Graham & Heimsch 1960; Bryant 1977; Holloway et al. 1987 for pollen analyses of east-central Texas bogs).

Additionally, the Mississippi River/Embayment has been a migration barrier since the Eocene (Rock 1957; Blair 1958; Sorrie & Weakley 2001). Many of the similarities between east and west have come about in the last 6000 years as the climates have approximated one another. Sandylands of the WGCP retain a distinctive flora rich in endemic and near-endemic taxa, which express more clearly than other communities in the region a long and distinctive phylogenetic history. The flora of many WGCP xeric sandylands has been enriched by the addition of taxa more widespread in the Coastal Plain. In contrast, xeric sandylands along the western drier boundary of the WGCP appear to retain a greater percentage of taxa locally characteristic of the region and with a relatively longer affiliation with it (McBryde 1933).

Our data on endemism coupled with palynological and climatic data strongly suggest that communities analogous, if not homologous, to xeric sandylands may have been a significant component of the WGCP since the last glaciation and perhaps earlier. Open oak-hickory woodlands and savannas with a rich herbaceous layer and many openings may have been the characteristic landscape over broad areas; perhaps moving south during glacial advances and north again with their retreat.

We suggest that the WGCP should no longer be overlooked as a distinct and critical region of endemism within the Coastal Plain. It may be more meaningful to look upon it as a dynamic entity with an independent and, to a certain extent, isolated ecological and biological history.

APPENDIX 1

Endemics (E) and near-endemics (NE) of the West Gulf Coastal Plain. Nomenclature follows Kartesz and Meacham (1999) in most cases. Community (habitat) types in brackets (see Appendix 2).

AGAVACEAE

Yucca louisianensis Trel., (E) [1]

ALISMATACEAE

Sagittaria papillosa Buchenau, (NE) [6]

APIACEAE

Eryngium hookeri Walp., (NE) [9 & 13]

ASTERACEAE

Berlandiera pumila (Michx.) Nutt. var. *scabrella* G.L. Nesom & B.L. Turner, (E) [1]
Chrysopsis texana Nesom, (E) [1]
Coreopsis intermedia Sherff, (E) [1]
Echinacea sanguinea Nutt., (E) [1]
Evax candida (Torr. & A. Gray) A. Gray, (NE) [1]
Gaillardia aestivalis (Walter) H. Rock var. *winkleri* (Cory) B.L. Turner, (E) [1]
Helenium drummondii H. Rock, (E) [4]
Helianthus debilis Nutt. ssp. *silvestris* Heiser, (E) [1]
Helianthus occidentalis Riddell ssp. *plantagineus* (Torr. & A. Gray) Shinners, (NE) [1]
Hymenopappus artemisiifolius DC., (NE) [1]
Hymenopappus carrizoanus B.L. Turner, (NE) [1]
Krigia wrightii (A. Gray) K.L. Chambers ex K.J. Kim, (NE) [ ]
Lactuca hirsuta Muhl. ex Nutt. var. *albiflora* (Torr. & A. Gray) Shinners, (NE) [1]
Liatris cymosa (H. Ness) K. Schumann, (E) [7]
Liatris tenuis Shinners, (E) [2]
Oligoneuron nitidum (Torr. & A. Gray) Small, (NE) [7]
Palafoxia hookeriana Torr. & A. Gray, (E) [1]
Palafoxia reverchonii (Bush) Cory, (E) [1]
Rudbeckia maxima Nutt., (NE) [13]
Rudbeckia scabrifolia L.E. Brown, (E) [10]
Rudbeckia texana (Perdue) P.Cox & Urbatsch, (NE) [4]
Solidago ludoviciana (A. Gray) Small, (NE) [1]
Symphyotrichum puniceum (L.) A. & D. Love var. *scabricaule* (Shinners) G.L. Nesom, (E) [4]
Tetragonotheca ludoviciana (Torr. & A. Gray) A. Gray ex Hall, (E) [1]
Thelesperma flavodiscum (Shinners) B.L. Turner, (E) [1]
Vernonia texana (A. Gray) Small, (NE) [1]

BRASSICACEAE

Leavenworthia aurea Torr. var. *texana* (Mahler) Rollins, (E) [7]
Lesquerella angustifolia (Nutt. ex Torr. & A. Gray) S. Watson, (E) [7]
Lesquerella pallida (Torr. & A. Gray) S. Watson, (E) [7]

CAMPANULACEAE

Lobelia puberula Michx. var. *pauciflora* Bush, (NE) [4]

CAPPARACEAE

Polanisia erosa (Nutt.) H.H. Iltis, (E) [1]

CARYOPHYLLACEAE

Paronychia drummondii Torr. & A. Gray, (E) [1]

Paronychia setacea Torr. & A. Gray, (NE) [1]
Silene subciliata B.L. Robins, (E) [2]

COMMELINACEAE
Tradescantia reverchonii Bush, (NE) [1]
Tradescantia subacaulis Bush, (E) [1]

CUSCUTACEAE
Cuscuta gronovii Willd. ex J.A. Schultes var. *calyptrata* Engelm., (E) [11]

CYPERACEAE
Fuirena bushii Kral, (NE) [4]
Rhynchospora glomerata (L.) Vahl. var. *angusta* Gale, (NE) [4,10]

EUPHORBIACEAE
Euphorbia bicolor Engelm. & A. Gray, (NE) [13]

FABACEAE
Amorpha paniculata Torr. & A. Gray, (E) [4]
Astragalus distortus Torr. & A. Gray var. *engelmannii* (E. Sheld.) M.E. Jones, (E) [1]
Astragalus leptocarpus Torr. & A. Gray, (NE) [1]
Astragalus soxmaniorum Lundell, (E) [1]
Baptisia bracteata Muhl. ex Elliott var. *laevicaulis* (A. Gray ex W. Canby) Isely, (NE) [2,13]
Baptisia nuttalliana Small, (NE) [1]
Dalea phleoides (Torr. & A. Gray) Shinners var. *phleoides*, (NE) [1]
Dalea villosa (Nutt.) Spreng var. *grisea* (Torr. & A. Gray) Barneby, (E) [1]
Mimosa hystricina (Small) B.L. Turner, (NE) [1]
Pediomelum hypogaeum (Nutt. ex Torr. & A. Gray) Rydb. var. *subulatum* (Bush) J.W. Grimes, (NE) [1]
Trifolium amphianthum Torr. & A. Gray, (NE) [2,13]
Trifolium bejariense Moric., (E) [1]

GENTIANACEAE
Bartonia texana Correll, (E) [10]

HYDROPHYLLACEAE
Nemophila phacelioides Nutt., (NE) [9]
Phacelia glabra Nutt., (NE) [13]

IRIDACEAE
Iris hexagona Walter var. *flexicaulis* (Small) R. Foster, (NE) [6]
Sisyrinchium sagittiferum Bicknell, (E) [4]

LAMIACEAE
Brazoria truncata (Benth.) Engelm. & A. Gray var. *pulcherrima* (Lundell) M.W. Turner, (E) [1]
Brazoria truncata (Benth.) Engelm. & A. Gray var. *truncata*, (NE) [1]
Monarda lindheimeri Engelm. & A. Gray ex A. Gray, (E) [5,13]
Monarda viridissima Correll, (E) [1]
Physostegia digitalis Small, (E) [2]
Physostegia longisepala Cantino, (E) [4,13]
Physostegia pulchella Lundell, (NE) [11]
Rhododon ciliatus (Benth.) Epling, (E) [1]
Scutellaria cardiophylla Engelm. & A. Gray, (E) [1]

LILIACEAE
Trillium gracile J.D. Freeman, (E) [8]
Trillium texanum Buckley, (E) [10]

MALVACEAE
Hibiscus dasycalyx Blake & Shiller, (E) [11]

MORACEAE
Maclura pomifera (Raf.) C.K. Schneid., (E) [11]

NYCTAGINACEAE
Abronia macrocarpa L. Galloway, (E) [1]

ONAGRACEAE
Oenothera heterophylla Spach ssp. *heterophylla*, (NE) [1]

ORCHIDACEAE
Spiranthes parksii Correll, (E) [7]

PAPAVERACEAE
Argemone albiflora Hornem. ssp. *texana* G.B. Ownbey, (NE) [1]

POACEAE
Panicum brachyanthum Steud., (NE) [4]
Sporobolus silveanus Swallen, (E) [7]

POLEMONIACEAE
Phlox cuspidata Scheele, (NE) [ ]
Phlox drummondii Hook. var. *drummondii*, (NE) [1]
Phlox nivalis Lodd. ex Sweet ssp. *texensis* Lundell, (E) [1]

POLYGONACEAE
Eriogonum longifolium Nutt. var. *plantaginium* Engelm. & A. Gray, (E) [1]
Eriogonum multiflorum Benth., (NE) [1]
Polygonella parksii Cory, (E) [1]

RANUNCULACEAE
Delphinium carolinianum Walter ssp. *vimineum* (D. Don) M.J. Warnock, (NE) [1]
Thalictrum arkansanum Boivin, (NE) [11]
Thalictrum texanum (A. Gray) Small, (E) [11]

ROSACEAE
Crataegus nananixonii Phipps & R.O'Kennon, (E) [1]

Crataegus warneri Sarg., (E) [1]

SCROPHULARIACEAE

Agalinis caddoensis Pennell, (E) [ ]

Agalinis navasotensis M. Dubrule & J. Canne-Hilliker, (E) [7]

Gratiola flava Leavenw., (NE) [7]

Penstemon murrayanus Hook., (NE) [1]

SOLANACEAE

Physalis mollis Nutt.var. *variovestita* (Waterfall) Sullivan, (NE) [1]

VALERIANACEAE

Valerianella florifera Shinners, (NE) [1]

APPENDIX 2

Community classification of West Gulf Coastal Plain (from Turner et al. 1999; The Nature Conservancy [TNC] designations in brackets [Weakley et al. 1999]).

1. Xeric sandylands. Grossarenic dry uplands (*Tragia* group). As a modification of this type we emphasize the xeric conditions, notably areas referred to as xeric sandylands and Post Oak-Blue Jack Oak Savanna.[TNC 305 and 320 in part].
2. Upland pine savanna, mixed woodlands. Arenic dry upland (*Schizachyrium* group). [TNC 305 and 307 in part].
3. Loamy dry-mesic uplands (*Schizachyrium*, *Callicarpa*, and *Chasmanthium* groups). We modify this entry to exclude communities where *Drosera* group (see below) dominates and place them with the next entry. [TNC 307 in part].
4. Bogs, wet pine savannas. Sandy/loamy wet herbaceous seeps and wetland pine savannas (*Drosera* group). [TNC 330 and 347].
5. Calcareous forest. Clayey dry mesic upland (*Chasmanthium* group). [TNC 375 in part].
6. Mayhaw pond. Clayey wet upland depression (*Justicia* group). [TNC 340].
7. Barrens, glades, and weches barrens (*Bigelowia*, *Callirhoe*, *Dalea* groups). Open, herb-dominated areas on bedrock exposures. [TNC 350].
8. Beech slopes. Mesic lower slopes and terraces (*Callicarpa* and *Mitchella* groups). [TNC 308].
9. Stream course. Loamy mesic stream bottom (*Mitchella* and *Arisaema* groups) and loamy wet-mesic stream bottoms (*Bignonia* and *Justicia* groups). [TNC 365 in part]
10. Baygall. Loamy wet forested seeps (*Osmunda* group). [TNC 360].
11. Floodplain, bottomland hardwood/river bottom communities; includes swamps (*Callicarpa*, *Bignonia*, *Justicia*, and *Ceratophyllum* groups). This combines Turner et al.(1999) community types 12–15. [TNC 385].
12. Open ponds and emergent marshes (not in Turner et al. 1999). [TNC 345].
13. Prairies (not in Turner et al. 1999). [TNC 375 in part].

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ANNOTATED CHECKLIST OF THE VASCULAR FLORA OF THE HICKORY CREEK UNIT OF THE BIG THICKET NATIONAL PRESERVE, TYLER COUNTY, TEXAS

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ABSTRACT

An annotated, vouchered checklist is provided of the vascular plant taxa of the 284 hectares Hickory Creek Unit of the Big Thicket National Preserve, Tyler County, in southeast Texas. The Hickory Creek Unit consists of four plant communities: wetland pine savanna, upland pine savanna, pond, and baygall. Four hundred one taxa are documented and their community affiliations are given. Previous lists for this unit numbered over 500 taxa. We believe that the discrepancy is the result of the larger lists being, in part, "conceptual" (what could be there, not what was actually there).

KEY WORDS: Big Thicket National Preserve, floristics, Hickory Creek Unit, Texas

RESUMEN

Se ofrece un catalogo anotado, con pliegos testigo de los taxa de plantas vasculares de las 284 hectareas de la Hickory Creek Unit de la Big Thicket National Preserve, Condado de Tyler, en el sureste de Texas. La Hickory Creek Unit consiste en cuatro comunidades vegetales: sabana húmeda de pinos, sabana en tierras altas de pinos, estanque, y matorral de Ilex coriacea. Se documentan cuatrocientos un taxa y se da la filiación a su comunidad. Los listados previos de esta unidad contenían más de 500 taxa. Creemos que la discrepancia es el resultado de que las grandes listas fueron en parte "conceptuales" (lo que puede estar allí, no lo que está actualmente allí).

INTRODUCTION

The Big Thicket region of southeast Texas has been characterized as floristically rich (Gunter 1971; Eisner 1973; Ajilvsgi 1979; Watson 1979, 1986; Peacock 1994; Official Guide 1997), a characterization that persists in spite of the fact that botanically the entire area is understudied and underdocumented. As yet, there is no vouchered and annotated plant list for the Big Thicket region, for the Big Thicket National Preserve, or for any of the twelve Big Thicket National Preserve units. The best plant lists from the entire area are the one for the Roy E. Larsen Sandylands Sanctuary, Hardin County (Matos & Rudolph 1985) and the one for the Little Thicket Nature Sanctuary, San Jacinto County (Peterson & Brown 1983). Even at the county level, the only vouchered lists are those of

Nesom and Brown (1998), which are considered by the authors to be "preliminary." All other plant lists for the Big Thicket region, beginning with Parks & Cory (1936) and continuing through Watson (1982), U.S. National Park Service (1993), and Yu (n.d.) are unannotated and are not based on vouchered specimens. Consequently there is no way to determine whether the lists represent what the author found or whether they represent what Cozine (1993) calls a "speculative checklist"; a conjectural compilation of what possibly might be there, not what is actually known to be there.

The purpose of this study was to begin a baseline floristic list for the Big Thicket region and the Big Thicket National Preserve by producing an annotated, vouchered checklist of the vascular flora for one unit of the Big Thicket National Preserve.

SITE AND METHODS

The Big Thicket is located mostly within the longleaf pine region of the West Gulf Coastal Plain in southeast Texas (Parks & Cory 1936; McLeod 1971; Harcombe & Marks 1979; Marks & Harcombe 1981; Harcombe et al. 1993). The Big Thicket National Preserve consists of 12 units scattered over seven Texas counties. The units range from 222 hectares to 10,100 hectares and total about 34,000 hectares (Peacock 1994). The unit we selected for a floristic inventory is the 284 hectare Hickory Creek Unit, located in southern Tyler County (Fig. 1). The Hickory Creek Unit, which consists of four plant communities (pond, wetland pine savanna, upland pine savanna, baygall), was chosen for inclusion in the Big Thicket National Preserve because of its pine savannas (see Ajilvsgi [1979]; Watson [1979], Harcombe & Marks [1981]; and MacRoberts & MacRoberts [1998] for descriptions of these communities). The natural characteristic of the unit was relatively flat open "grasslands" with scattered longleaf pines. The unit has little relief and ranges from 35 meters to 42 meters elevation. Aerial photographs show the unit still partly open in 1974 when the Big Thicket National Preserve acquired it, but most openings have subsequently been invaded by shrubs and offsite pines due largely to fire suppression and dormant-season prescription burns (Streng & Harcombe 1982; McClung 1988; Bridges & Orzell 1989; MacRoberts & MacRoberts 2000). Details regarding edaphic and climatic factors of the Hickory Creek Unit can be found in Deshotels (1978), Watson (1979), Marks and Harcombe (1981), and Streng and Harcombe (1982). A map of the unit is in Harcombe and Marks (1979) and in Streng and Harcombe (1982).

Like all the units of the Big Thicket National Preserve, the Hickory Creek Unit has not been the subject of a floristic inventory although extensive but desultory collecting and floristic sampling has occurred there (Streng 1979; Streng & Harcombe 1982; Watson 1982). Nonetheless, the Hickory Creek Unit is perhaps the best collected unit of the Big Thicket National Preserve. Streng (1979 and Streng & Harcombe 1982) conducted a study of factors affecting tree

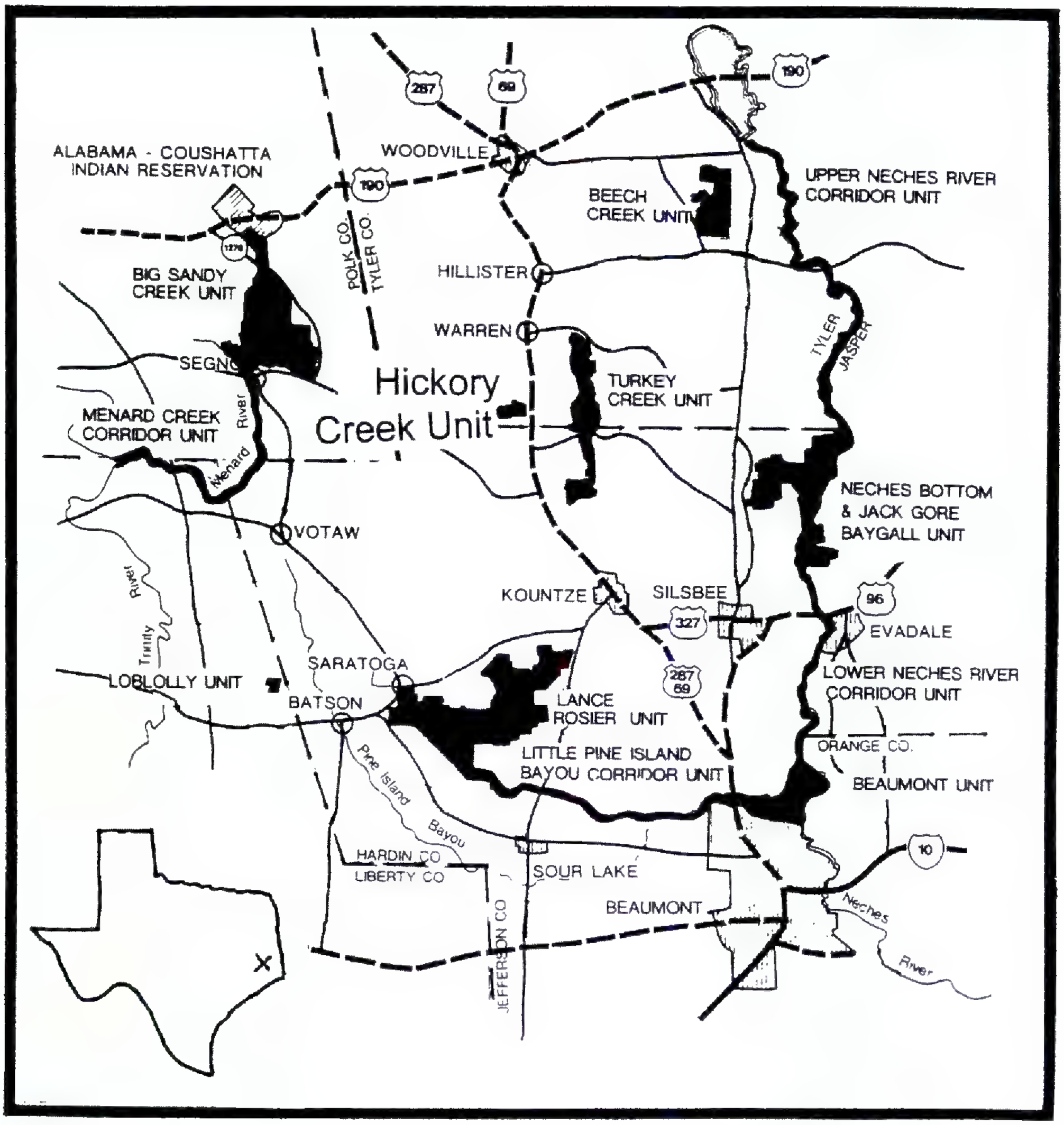


Fig. 1. Location of Hickory Creek Unit within the Big Thicket National Preserve, Texas.

density in the Hickory Creek Unit in the late 1970s and made extensive plant collections. Geraldine Watson, former botanist with the Big Thicket National Preserve, also collected there in the 1970s and 1980s. Their plant specimens have been housed largely at Rice and Lamar universities along with a few collections by Paul Harcombe, Peter Marks, and C. Liu. These collections number about 300 sheets. There are also a few collections housed at SHST and SBSC.

The MacRoberts' collected 430 specimens from the Hickory Creek Unit during 13 field trips beginning 7 March 2000 and ending 13 September 2001. Larry Brown collected about 179 specimens from the unit during four field trips between 27 April and 5 October 2001 (he had previously collected about 30 specimens between 1979 and 1997).

Since our purpose is to produce a list of taxa known to occur on the Hickory Creek Unit, a vouchered specimen was considered to be the only evidence acceptable for inclusion in the list. In all, about 950 herbarium specimens form the data for this report.

Rejected are three previous lists: Watson (1982) produced a list of about 530 taxa for the Hickory Creek Unit, the U.S. National Park Service (1993) produced a list of about 1200 taxa for the entire Big Thicket National Preserve, and Yu (n.d.) produced a list of 525 taxa, excluding trees, for the Hickory Creek Unit. The Yu and National Park Service lists are based largely on the Watson list. Aside from being unannotated and not vouchered, inclusion criteria are not explained for any of these lists. Also, all three lists were found to have extensive misidentifications and dubious entries (Brown & Brown 1996; Brown n.d.).

Nomenclature follows Kartesz (1994), Jones et al. (1997), and Kartesz and Meacham (1999) in most cases.

The following abbreviations are used:

CL = C. Liu. His specimens are at Rice University.

DS = Donna Streng. Her collections are unnumbered and are at Rice University.

GW = Geraldine Watson. Unless otherwise indicated, her National Park Service specimens are at Rice University.

LB = Larry Brown. Unless otherwise indicated, his specimens are at SBSC.

McL = C.A. McLeod. His collections are unnumbered and are at SHST.

MM – Barbara R. and Michael H. MacRoberts. Except where noted, their collections are temporarily at Rice University.

MW = Michael Warnock. His specimens are at SHST.

PH = Paul Harcombe. His specimens are at Rice University.

PM = Peter Marks. His collections are at Rice University.

* = exotic

+ = see note at end of list.

The MacRoberts, Streng, Watson, Harcombe, Marks, and Liu specimens have been annotated by Larry Brown (Brown & Brown 1996; Brown n.d.). Barbara MacRoberts and Justin Williams examined the specimens of McLeod and Warnock at SHST. Where we had more than one voucher, up to four have been listed (see annotated list under results).

In addition to the taxa listed, we designate the plant community or communities with which we found each species most closely associated. Community abbreviations are given below and are put in parentheses (see Ajilvsgi [1979] for additional description of these communities).

(U) = Upland pine savanna (aka Longleaf-Bluestem Uplands).

(W) = Wetland pine savanna (aka Longleaf-Blackgum Savannas).

(B) = Baygall/Stream course. A small part of this is Sweetgum-Oak Floodplain and Palmetto-Oak Flats.

(P) = Ephemeral pond. (These shallow ponds, which may become dry in drought years, but hold water longer than other areas, have not been adequately described on the Big Thicket.)

RESULTS

Annotated list of the vascular plants found in the Hickory Creek Unit taxa.

ACANTHACEAE

Justicia ovata (Walt.) Lindau var. *lanceolata* (Chapman) R.W. Long, (**P,W**) *MM 4416; LB 25539*

Ruellia humilis Nutt., (**U**) *DS; MM 4245, 4452, 4527*

ACERACEAE

Acer rubrum L. var. *rubrum*, (**W**) *MM 4861*

AGAVACEAE

Manfreda virginica (L.) Salisb. ex Rose, (**U**) *GW 2285; DS; MM 4699*

Yucca louisianensis Trel., (**U**) *MM 4838*

ALISMATACEAE

Sagittaria papillosa Buch., (**P**) *GW 2298; DS; MM 4141, 4160*

ANACARDIACEAE

Rhus copallinum L., (**U**) *MW 6490*

Toxicodendron pubescens P. Mill., (**U**) *LB 19236, 26135*

Toxicodendron radicans (L.) Kuntze, (**U**) *LB 25164*

ANNONACEAE

Asimina parviflora (Michx.) Dunal, (**U**) *MM 4284, 4442*

APIACEAE

Centella erecta (L.f.) Fern., (**W**) *DS; MM 4172, 4402*

Eryngium integrifolium Walt., (**W**) *PM s.n.; MM 4708, 4814; LB 26380*

Eryngium yuccifolium Michx., (**U**) *DS; MM 4497*

Oxypolis filiformis (Walt.) Britt. ssp. *filiformis*, (**W,P**) *DS; MM 4705; LB 26128*

Ptiliminium nuttallii (DC.) Britt., (**W**) *McL s.n.*

AQUIFOLIACEAE

Ilex coriacea (Pursh) Chapman, (**W,B**) *MM 4862*

Ilex opaca Ait., (**U**) *MM 4827*

Ilex vomitoria Ait., (**U**) *MM 4830*

ARECACEAE

Sabal minor (Jacq.) Pers., (**W,B**) *MM 4866*

ARISTOLOCHIACEAE

Aristolochia reticulata Jacq., (**U**) *MM 4272*

ASCLEPIADACEAE

Asclepias amplexicaulis Sm., (**U**) DS

Asclepias longifolia Michx. ssp. *longifolia*, (**W**) *MM 4504*

Asclepias obovata Ell., (**U**) *GW 2215; DS; LB 25550*

Asclepias tuberosa L., (**U**) *GW 2214;* DS

ASTERACEAE

Ambrosia artemisiifolia L., (**U**) *MM 4758*

Arnoglossum ovatum (Walt.) H.E. Robins., (**W**) *DS; MM 4494, 4706*

Baccharis halimifolia L., (**U**) *MM 4912*

Berlandiera pumila (Michx.) Nutt. var. *pumila*, (**U**) *DS; MM 4277; LB 25152, 26359*

Bidens aristosa (Michx.) Britt., (**U**) *DS; MM 4759*

Boltonia diffusa Ell., (**W**) *GW 3429; DS; MM 4533*

Chrysopsis mariana (L.) Ell., (**U**) *DS; MM 4449*

Chrysopsis pilosa Nutt., (**U**) *MM 4697, 4768*

Cirsium horridulum Michx., (**U**) *MM 4834*

Conoclinium coelestinum (L.) DC., (**U**) *MM 4756*

Conyza canadensis (L.) Cronq., (**U**) *MM 4762*

Coreopsis linifolia Nutt., (**W**) *PM s.n.; MM 4794*

Coreopsis tinctoria Nutt., (**U**) DS

Echinacea sanguinea Nutt., (**U**) *DS; MM 4439, 4453, 4528*

Elephantopus carolinianus Raeusch., (**U**) *LB 26347*

Elephantopus tomentosus L., (**U**) *MM 4447*

Erechtites hieraciifolia (L.) Raf. ex DC., (**U**) *LB 26161*

Erigeron strigosus Muhl. ex Willd., (**U**) *GW 2302; DS; MM 4162; LB 25165*

Eupatorium capillifolium (Lam.) Small, (**U**) *MM 4913*

Eupatorium compositifolium Walt., (**U**) *PH & CL 901108*

Eupatorium hyssopifolium L., (**W**) *MM 4810; LB 25537, 26150, 26351*

Eupatorium lancifolium (T. & G.) Small, (**U**) *LB 26138, 26139*

Eupatorium leucolepis (DC.) T. & G., (**W**) *GW 2181; DS; MM 4520; LB 26355*

Eupatorium mohrii Greene, (**U**) *GW 2182; LB 8150, 25545, 26379*

Eupatorium rotundifolium L., (**W**) *GW 404, 2282; DS; MM 4539*

Eupatorium semiserratum DC., (**U**) *LB 25538*

Eurybia hemispherica (Alexander) Nesom, (**U**) *DS; MM 4787*

Euthamia leptocephala (T. & G.) Greene, (**U**) *GW 3460*

Facelis retusa* (Lam.) Schultz-Bip., (U**) *GW 3348*

Gamochaeta purpurea (L.) Cabrera, (**U**) *MM 4248; LB 25171*

Helenium amarum (Raf.) H. Rock, (**U**) DS
Helenium drummondii H. Rock, (**W**) *DS; MM 4146*
Helenium flexuosum Raf., (**U**) *DS; MM 4237, 4458*
Helianthus angustifolius L., (**W,U**) *PM s.n.; DS; MM 4455, 4456*
Helianthus annuus L., (**U**) DS
Helianthus debilis Nutt., (**U**) *GW 2357*
Helianthus mollis Lam., (**U**) *GW 2183; DS; MM 4700*
Hieracium gronovii L., (**U**) *MM 4839*
Hymenopappus artemisiifolius DC., (**U**) *MM 4300*
Liatris acidota Engelm. & Gray, (**W**) *PH 901105; MM 4538; LB 26131a*
Liatris elegans (Walt.) Michx., (**U**) *DS; MM 4764*
Liatris pycnostachya Michx., (**U,W**) *DS; MM 4801*
Marshallia graminifolia (Walt.) Small, (**W**) *PM s.n.; DS; MM 4507, 4702*
Oligoneuron nitidum (T. & G.) Small, (**U**) *GW 354; DS; MM 4532*
Pityopsis graminifolia (Michx.) Nutt., (**U**) *DS; MM 4766*
Pluchea foetida (L.) DC., (**W,P**) *DS; MW 6496; MM 4519, 4701*
Pluchea rosea Godfrey, (**W,P**) *MM 4511, 4712, 4714*
Rudbeckia grandiflora (D.Don) J.F.Gmel ex DC. var. *alismifolia* (T.& G.) Cronq., (**U**) *DS; MM 4526; LB 25561*
Rudbeckia hirta L., (**U**) *DS; MM 4448*
Silphium gracile Gray, (**U**) *MM 4294, 4524, 4698*
Solidago canadensis L., (**U**) *LB 26367*
Solidago ludoviciana (Gray) Small, (**U**) *DS; LB 26146, 26148, 26162*
Solidago odora Ait., (**U**) *MM 4767; LB 5574*b [RICE]
Solidago rugosa P. Mill., (**B**) *GW 3461*
Soliva sessilis* Ruiz & Pavon, (U**) *LB 25150*
Symphyotrichum dumosum (L.) Nesom, (**B,W,U**) *GW 2278; DS; MM 4457, 4534*
Symphyotrichum patens (Ait.) Nesom, (**U**) *GW 3427*
Symphyotrichum pratense (Raf.) Nesom, (**U**) *GW 3428; DS; MM 4291, 4531*
Vernonia texana (Gray) Small, (**U**) *PH* & Liu *901110; DS; LB 26136*

BIGNONIACEAE

Bignonia capreolata L., (**U**) *MM 4254*

BLECHNACEAE

Woodwardia areolata (L.) T. Moore, (**B**) *MM 4886, 4950*
Woodwardia virginica (L.) Sm., (**W,B**) *MM 4155, 4304; LB 19231*

BUDDLEJACEAE

Polypremum procumbens L., (**U**) *DS; MM 4537*

CAMPANULACEAE

Lobelia appendiculata A. DC., (**U**) *DS; MM 4236*
Lobelia flaccidifolia Small, (**W**) *MM 4399, 4900*
Lobelia puberula Michx., (**W,U**) *GW 2184, 3454; DS; MM 4784*
+*Lobelia reverchonii* B.L.Turner, (**W**) *GW 3453; DS; MM 4813*
Triodanis perfoliata (L.) Nieuwl. var. *biflora* (Ruiz & Pavon) Bradley, (**U**) *MM 4240*

CAPRIFOLIACEAE

Lonicera japonica* Thunb., (U**) *MM 4842*
Lonicera sempervirens L., (**U**) *LB 26354*
Viburnum dentatum L., (**U**) *MM 4180, 4303*

CISTACEAE

Helianthemum carolinianum (Walt.) Michx., (**U**) DS
Lechea mucronata Raf., (**U**) *DS; LB 26140*
Lechea tenuifolia Michx., (**U**) *LB 19510*

CLUSIACEAE

Hypericum crux-andreae (L.) Crantz, (**W**) *DS; MM 4509; LB 26137*
Hypericum galioides Lam., (**W**) *PM s.n.; DS; MM 4157, 4424*
Hypericum gentianoides (L.) B.S.P., (**U**) *DS; MM 4500; LB 25572*
Hypericum gymnanthum Engelm. & Gray, (**U**) *LB 25571*
Hypericum hypericoides (L.) Crantz., (**U**) *MM 4899*
Hypericum mutilum L., (**P**) *LB 26131*

COMMELINACEAE

Commelina virginica L., (**U**) DS
Tradescantia hirsutiflora Bush, (**U**) *MM 4943*

CONVOLVULACEAE

Ipomoea cordatotriloba Dennst., (**U**) *MM 4785*
Ipomoea pandurata (L.) G.F.W. Mey., (**U**) *DS; LB 26127*
Jacquemontia tamnifolia (L.) Griseb., (**U**) *MM 4788*

CORNACEAE

Cornus florida L., (**U**) *MM 4852*
Nyssa biflora Walt., (**P,B,W**) *GW 2253; MM 4493; LB 25166*
Nyssa sylvatica Marsh., (**W,B**) *MM 4311, 4909, 4910; MW 3288*

CUSCUTACEAE

+*Cuscuta* sp., (**U**) *MM 4919*

CYPERACEAE

Carex complanata Torr. & Hook., (**B,U**) *MM 4888*
Carex frankii Kunth., (**P**) DS
Carex glaucescens Ell., (**P,B**) *DS; LB 25560*
Carex intumescens Rudge, (**P,B**) *MM 4885*
Cyperus croceus Vahl, (**U**) *MM 4774*
Cyperus haspan L., (**W**) *GW 2202* [SHST]; *DS; LB 26363*b
Cyperus retrorsus Chapman, (**U**) *LB 26370*
Cyperus virens Michx., (**P**) DS
Eleocharis microcarpa Torr., (**P,W**) *MM 4394*
Eleocharis tuberculosa (Michx.) Roemer & J.A. Schultes, (**P,W**) *MM 4265, 4282, 4401, 4406*
Fimbristylis dichotoma (L.) Vahl., (**W**) *MM 4395*
Fuirena breviseta (Coville) Coville, (**W,P**) *MM 4709; LB 26152*
Fuirena bushii Kral, (**W,P**) *MM 4387, 4536; LB 25548, 25551*
Fuirena squarrosa Michx., (**W**) *GW 2196* [SHST]
Isolepis carinata Hook. & Arn. ex Torr., (**W,U**) *MM 4878, 4891*
Rhynchospora colorata (L.) H. Pfeiffer, (**P,W**) DS
Rhynchospora corniculata (Lam.) Gray, (**P**) *LB 25548, 26151*
Rhynchospora elliottii A. Dietr., (**P,W**) *MM 4151, 4463, 4938; LB 25519*
Rhynchospora filifolia Gray, (**P,W**) *MM 4461, 4545*b; *LB 25557*
Rhynchospora glomerata (L.) Vahl., (**W**) DS
Rhynchospora gracilenta Gray, (**W**) *MM 4421; LB 25525, 25529, 25542*a
Rhynchospora harveyi W. Boott, (**W**) *LB 25565*
Rhynchospora inexpansa (Michx.) Vahl., (**W**) *LB 25531*
Rhynchospora latifolia (Baldw. ex Ell.) W. Thomas, (**P,W**) *GW 2216; MM 4460*
Rhynchospora oligantha Gray, (**W**) *MM 4250, 4310; LB 25521*a
Rhynchospora perplexa Britt., (**W**) *MM 4513; LB 4483* [RICE], *25555*
Rhynchospora plumosa Ell., (**W**) *DS; MM 4249, 4259; LB 25172*
Rhynchospora pusilla Chapman ex M.A. Curtis, (**W**) *DS; MM 4389; LB 25563, 25573*
Rhynchospora rariflora (Michx.) Ell., (**W**) *MM 4252; LB 25521c*
Rhynchospora recognita (S. Gale) Kral, (**W**) *DS; MM 4293; LB 25536, 25547*
+*Scleria baldwinii* (Torr.) Steud., (**P,W**) *MM 4514; LB 25169, 25556*
Scleria ciliata Michx., (**W**) *LB 25144*
Scleria georgiana Core, (**W**) *MM 4260, 4407; LB 25177, 25524*
Scleria pauciflora Muhl. ex Willd., (**W**) *LB 25173*
Scleria reticularis Michx., (**P,W**) *LB 1606, 6606, 25524*b,
Scleria triglomerata Michx., (**W,U**) *MM 4916*

CYRILLACEAE

Cyrilla racemiflora L., (**B,W**) *MW 3978, 6483; MM 4869*

DENNSTAEDTIACEAE

Pteridium aquilinum (L.) Kuhn, (**U**) *MM 4302, 4865*

DROSERACEAE

Drosera brevifolia Pursh, (**W**) *MM 4163*
Drosera capillaris Poir., (**W**) *MM 4306, 4432*

EBENACEAE

Diospyros virginiana L., (**U,W**) *MM 4901; LB 26360*

ERICACEAE

Lyonia mariana (L.) D. Don, (**W,B**) *MM 4871*
Rhododendron viscosum (L.) Torr., (**U,W,B**) *DS; MM 4450*
Vaccinium arboreum Marsh., (**U**) *MM 4288*
Vaccinium corymbosum L., (**U**) *MM 4147, 4153, 4168; LB 26134*
Vaccinium stamineum L., (**U**) *DS; MW 3291; McL*

ERIOCAULACEAE

Eriocaulon decangulare L., (**W**) *GW 3365; DS; MM 4423; LB 19234*
Lachnocaulon anceps (Walt.) Morong, (**W**) *GW 3368; DS; MM 4239, 4434*

EUPHORBIACEAE

Chamaesyce maculata (L.) Small, (**U**) *LB 26345*
Cnidoscolus texana (Muell.-Arg.) Small, (**U**) *MM 4904*
Croton argyranthemus Michx., (**U**) *DS; MM 4292, 4775*
Croton capitatus Michx., (**U**) *MM 4757*
Croton willdenowii G.L. Webster, (**U**) *LB 14891, 19509, 25523, 25553*
Euphorbia corollata L., (**U**) *DS; MM 4777*
Phyllanthus urinaria* L., (U**) *LB 26348*
Stillingia sylvatica Garden ex L., (**U**) *MM 4246*
Tragia smallii Shinners, (**U**) *MM 4441; LB 19230, 25148*
Tragia urticifolia Michx., (**U**) *DS; MM 4238; LB 25149, 25163*

Triadica sebifera (L.) Small, (**U,B,W**) *MM 4850*

FABACEAE

Aeschynomene indica L., (**U**) *LB 14893*
Albizia julibrissin* Durz., (U**) *LB 26349*
Baptisia nuttalliana Small, (**U**) *MM 4835, 4854, 4873*
Centrosema virginianum (L.) Benth., (**U**) *MW 6493*
Chamaecrista fasciculata (Michx.) Greene, (**U**) *DS; LB 26144*
Crotolaria sagittalis L., (**U**) *DS; MM 4256; LB 26142*
Desmodium paniculatum (L.) DC., (**U**) *LB 26350, 26366*
Kummerowia striata* (Thunb.) Schindl., (U**) *GW 2339*
Mimosa hystricina (Small) B.L. Turner, (**U,W**) *DS; MM 4289, 4440; LB 26163*
Orbexilum simplex (Nutt. ex T. & G.) Rydb., (**U**) *DS; MM 4915; LB 25157*
Rhynchosia latifolia Nutt. ex T. & G., (**U**) DS
Strophostyles umbellata (Muhl. ex Willd.) Britt., (**U**) *PH* & Liu *901107*
Stylosanthes biflora (L.) B.S.P., (**U**) DS
Tephrosia onobrychoides Nutt., (**W**) *DS; MM 4393; MW 6486*
Trifolium dubium* Sibthorp, (U**) *MM 4893*

FAGACEAE

Quercus falcata Michx., (**U**) *GW 2281; MM 4840, 4848, 4859*
Quercus hemisphaerica Bartr. ex Willd., (**B**) *MM 4889; LB 26358*
Quercus incana Bartr., (**U**) *MM 4273*
Quercus laurifolia Michx., (**U**) *LB 26159*
Quercus margarettiae Ashe ex Small, (**U**) *GW 2276*
Quercus marilandica Muenchh., (**U**) *MM 4837*
Quercus muehlenbergii Engelm., (**U**) *MM 4841*
Quercus nigra L., (**U,B**) *GW 2277; MM 4843; LB 26147*
Quercus similis Ashe, (**B**) *LB 25154*
Quercus stellata Wangenh., (**U**) *MM 4847*
Quercus virginiana P. Mill., (**U**) *DS; MM 4911*

GENTIANACEAE

Sabatia gentianoides Ell., (**W**) *DS; MM 4426, 4508*

HALORAGACEAE

Prosperpinaca pectinata Lam., (**P**) *MM 4540; LB 26160*

HAMAMELIDACEAE

Liquidambar styraciflua L., (**U,W**) *MM 4856*

HYDROPHYLLACEAE

Hydrolea ovata Nutt. ex Choisy, (**P**) *DS; MM 4713*

IRIDACEAE

Alophia drummondii (Graham) R.C. Foster, (**U**) *DS; MM 4451, 4529*
Sisyrinchium campestre Bickn., (**UW**) *MM 4144b, 4159, 4167, 4301* [SBSC]
Sisyrinchium rosulatum Bickn., (**U**) *MM 4257, 4914*
Sisyrinchium sagittiferum Bickn., (**U,W**) *GW 2304; MM 4137, 4167a*

JUNCACEAE

Juncus brachycarpus Engelm., (**U**) *MM 4944, 4948*
Juncus bufonius L., (**W**) *LB 25173*
Juncus dichotomus Ell., (**W**) *MM 4253, 4872, 4902; LB 25143*
Juncus diffusissimus Buckl., (**W**) *MM 4883*
Juncus effusus L., (**W**) DS
Juncus ellottii Chapman, (**W**) *DS; MM 4881; LB 25147, 25167*
Juncus marginatus Rostk., (**W**) *DS; LB 25159*
Juncus nodatus Coville, (**P**) *DS; MM 4939, 4940*
Juncus repens Michx., (**P**) *MM 4946*
Juncus scirpoides Lam., (**U**) DS
Juncus tenuis Willd., (**W**) *MM 4896; LB 25145*
Juncus validus Coville, (**P**) *MM 4945, 4247, 4427*

LAMIACEAE

Hedeoma hispida Pursh, (**U**) *MM 4894*
Hyptis alata (Raf.) Shinners, (**W**) *DS; MM 4495, 4802*
Monarda punctata L., (**U**) DS
Physostegia digitalis Small, (**W**) *GW 355; DS; MM 4525; LB 19235*
Prunella vulgaris L., (**U**) *MM 4255*
Pycnanthemum tenuifolium Schrad., (**U**) *MM 4454*
Scutellaria elliptica Muhl. ex Spreng., (**U**) *MM 4908; LB 25161*
Scutellaria integrifolia L., (**W**) *DS; MM 4295, 4917; LB 25161*
Trichostema dichotomum L., (**U**) *MM 4763*

LAURACEAE

Persea borbonia (L.) Spreng., (**U**) *LB 26352, 26377*
Persea palustris (Raf.) Sarg., (**U,B,W**) *MM 4166; MW 3980; LB 25534*
Sassafras albidum (Nutt.) Nees, (**U**) *MM 4855; LB 26376*

LENTIBULARIACEAE

Pinguicula pumila Michx., (**W**) *MM 4876; MW 4157*

Utricularia radiata Small, (**P**) *MM 4875*
Utricularia subulata L., (**W**) *GW 3384*; DS

LILIACEAE

Aletris aurea Walt., (**W**) *DS; MM 4242; MW 3977*
Allium canadense L., (**U,W**) *MM 4269*
Hymenocallis liriosme (Raf.) Shinners, (**P**) *GW 2332; MM 4145; LB 25170*
Hypoxis curtisii Rose, (**P**) *LB 26384*
Hypoxis rigida Chapman, (**W**) *MM 4270, 4897; LB 25142*
Nothoscordum bivalve (L.) Britt., (**U**) *MM 4143*
Schoenolirion croceum (Michx.) Wood, (**W**) *DS; MM 4173*
Tofieldia racemosa (Walt.) B.S.P., (**W**) *GW 350; DS; MM 4505; LB 19229*

LINACEAE

Linum medium (Planch.) Britt., (**U,W**) *PM 4; DS; MM 4251, 4422*

LOGANIACEAE

Gelsemium sempervirens A. St.-Hil., (**U**) *MM 4183*
Mitreola sessilifolia (J.F. Gmel.) G. Don, (**W**) *PM 1; DS; MM 4544*

LYCOPODIACEAE

Lycopodiella appressa (Chapman) Cranfill, (**W**) *PM 18; MM 4307, 4430, 4541*
Lycopodiella caroliniana (L.) Pichi Sermolli, (**W**) *GW 358*

LYGODIACEAE

Lygodium japonicum (Thunb.ex Murr.) Sw., (**U**) *LB 26164*

MAGNOLIACEAE

Magnolia grandiflora L., (**U**) *MM 4849*
Magnolia virginica L., (**W,B**) *MM 4305*

MALVACEAE

Hibiscus moscheutos L. ssp. *lasiocarpos* (Cav.) O.J. Blanchard, (**W,B,P**) *GW 2185; MM 4403, 4545*

MELASTOMATACEAE

Rhexia lutea Walt., (**W**) *DS; MM 4425, 4523*
Rhexia mariana L., (**W**) *DS; MM 4428, 4522*
Rhexia petiolata Walt., (**W**) DS

MYRICACEAE

Morella caroliniensis (P. Mill.) Small, (**B,W**) *MM 4170; McL; MW 3292*
Morella cerifera (L.) Small, (**U,B,W**) *MM 4828*

OLEACEAE

Chionanthus virginicus L., (**U**) *LB 25151*
Ligustrum sinense* Lour., (U**) *MM 4154, 4868*

ONAGRACEAE

Ludwigia hirtella Raf., (**W,U**) *DS; MM 4391, 4415; LB 25522*
Ludwigia linearis Walt., (**W**) *PM 13; DS; MM 4503, 4710*
Ludwigia pilosa Walt., (**P**) *MM 4790; LB 14895*
Oenothera linifolia Nutt., (**U**) *DS; MM 4235, 4244*

OPHIOGLOSSACEAE

Botrychium biternatum (Sav.) Underwood, (**U**) *MM 4898*

ORCHIDACEAE

Calopogon oklahomensis D.H. Goldman, (**W,U**) *MM 4864; GW 3358* [TAMU]
Calopogon tuberosus (L.) B.S.P., (**W**) *DS; MM 4429, 4937*
Isotria verticillata Raf., (**B**) *GW 1475*
Platanthera nivea (Nutt.) Luer, (**W**) *GW 349; DS; MW 6480; McL*
Pogonia ophioglossoides (L.) Ker-Gawl., (**W**) DS
Spiranthes brevilabris Lindl., (**W**) DS
Spiranthes praecox (Walt.) S. Wats., (**U,W**) *GW 3380; MM 4271, 4279*
Spiranthes tuberosa Raf., (**U, W**) *LB 18627*

OSMUNDACEAE

Osmunda cinnamomea L., (**W,B**) *MM 4863*
Osmunda regalis L., (**W,B**) *DS; MM 4158, 4261*

OXALIDACEAE

Oxalis dillenii Jacq., (**U**) *MM 4142, 4178*
Oxalis lyonii Pursh, (**U**) *GW 2303; MM 4161*
Oxalis violacea L., (**U**) *DS; LB 26385*

PASSIFLORACEAE

Passiflora lutea L., (**U**) *MM 4443*

PINACEAE

Pinus echinata P. Mill., (**U**) *MM 4836*
Pinus palustris P. Mill., (**W,U**) *MM 4857*
Pinus taeda L., (**W,U**) *MM 4858*

PLANTAGINACEAE

Plantago aristata Michx., (**U**) DS
Plantago virginica L., (**U**) *MM 4298*

PLATANACEAE

Platanus occidentalis L., (**U**) *LB 26369*

POACEAE

Andropogon gerardii Vitman, (**U**) DS
Andropogon ternaris Michx., (**U**) *GW 2270; LB 26365*

Andropogon virginicus L., (**W,P**) *GW 2272; DS; MM 4781, 4791*

Anthaenantia rufa (Nutt.) J.A. Schultes, (**W**) *GW 2284; DS; MM 4797; LB 26381*

Anthaenantia villosa (Michx.) Beauv., (**W**) *GW 2203, 2207; DS; LB 26364*

Aristida longespica Poir.var.*geniculata* (Raf.) Fern., (**U**) *GW 2219*; DS

Aristida palustris (Chapman) Vasey, (**P,W**) *GW 2205; MM 4704; LB 26153*

Aristida purpurascens Poir. var. *purpurascens*, (**U**) *MM 4783*

Aristida purpurascens Poir. var. *virgata* (Trin.) Allred, (**U,P,W**) *DS; MM 4800; LB 5576, 26143*

Axonopus fissifolius (Raddi) Kuhlm., (**U,W**) *DS; MM 4390, 4778*

Chasmanthium laxum (L.) Yates var. *laxum*, (**B**) *MM 5157*a, *5157*b; *LB 26344, 26368*

Coelorachis cylindrica (Michx.) Nash, (**U**) *MM 4942*

Coelorachis rugosa (Nutt.) Nash, (**P,W**) *GW 2188; DS; MM 4711; LB 26154*

Dichanthelium aciculare (Desv. ex Poir.) Gould & Clark, (**U**) DS

Dichanthelium acuminatum (Sw.) Gould & Clark var. *fasciculatum* (Torr.) Freckmann, (**P,U,W**) *DS; MM 4262; LB 25155, 25158*

Dichanthelium commutatum (J.A. Schultes) Gould, (**W**) *DS; MM 4275*

Dichanthelium consanguineum (Kunth) Gould & Clark, (**U,W**) *MM 4263, 4280, 4412; LB 19232*

Dichanthelium dichotomum (L.) Gould var.*tenue* (Muhl.) Gould & Clark, (**W**) *DS; LB 25146*a

Dichanthelium longiligulatum (Nash) Freckmann, (**W**) *MM 4234, 4462; LB 25168, 25175*

Dichanthelium scabriusculum (Ell.) Gould & Clark, (**W**) *MM 4392*

Dichanthelium scoparium (Lam.) Gould, (**U,W**) *MM 4411*

Dichanthelium sphaerocarpon (Ell.) Gould var. *sphaerocarpon*, (**U**) *MM 4290; LB 25554*

Dichanthelium sphaerocarpon (Ell.) Gould var. *isophyllum* (Scribn.) Gould & Clark, (**U**) *LB 25162*

Dichanthelium villosissimum (Nash) Freckmann, (**U,P,W**) *MM 4286, 4299, 4444; LB 26354*

Dichanthelium wrightianum (Scribn.) Freckmann, (**P**) *LB 26126*

Digitaria ciliaris (Retz.) Koel., (**U**) *LB 26346*

Digitaria cognata (Schult.) Pilger.ssp.*cognata*, (**U**) *MM 4779*

Digitaria ischaemum* (Schreb.) Schreb.ex Muhl., (U**) DS

Eragrostis elliottii S. Wats., (**W**) *GW 2247*

Eragrostis refracta (Ell.) Scribn., (**W**) *DS; MM 4796*

Eragrostis secundiflora J. Presl, (**U**) DS

Eragrostis spectabilis (Pursh) Steud, (**U**) *GW 2268, 2287; LB 14894, 26141*

Gymnopogon ambiguus (Michx.) B.S.P., (**U**) *GW 2312; DS; LB 6605*

+*Gymnopogon brevifolius* Trin., (**U**) *MM 4780* [SBSC]

Muhlenbergia capillaris (Lam.) Trin. var.*capillaris*, (**W**) *DS; MM 4793; LB 26373*

Panicum anceps Michx., (**W**) DS

Panicum brachyanthum Steud., (**U,W**) *DS; MM 4770*

Panicum hemitomon J.A. Schultes, (**P**) *LB 25543*

Panicum rigidulum Bosc ex Nees, (**P,U,W**) *MM 4715, 4772; LB 25558, 26106*

Panicum tenerum Bey. ex Trin., (**P,W**) *MM 4410, 4433, 4502, 4543, 4815;, LB 6669, 14896, 25523*a

Panicum verrucosum Muhl., (**W**) *MM 4812; LB 6607*

Panicum virgatum L., (**P,W**) DS

Paspalum bifidum (Bertol.) Nash, (**U**) *LB 6666*

Paspalum floridanum Michx., (**U,W**) *GW 2190; DS; MM 4771; LB 25528*

Paspalum laeve Michx., (**W**) *LB 26383*

Paspalum lividum Trin., (**P**) *GW 2222*

Paspalum notatum* Fluegge, (U**) DS

Paspalum plicatulum Michx., (**U,W**) *DS; MM 4243, 4388, 4501*

Paspalum praecox Walt., (**W**) *GW 2192; DS; MM 4404; LB 25541*

Paspalum setaceum Michx., (**W**) *GW 2221; DS; MM 4799; LB 25535*

Paspalum urvillei* Steud., (U**) DS

Poa annua* L., (U**) *MM 4831*

Saccharum giganteum (Walt.) Pers., (**P**) *CL 901176, 901177*

Sacciolepis indica* (L.) Chase, (P**) *GW 2194*

Schizachyrium scoparium (Michx.) Nash var. *divergens* (Hack.) Gould, (**U,W**) *GW 2186; DS; MM 4765; LB 26375*

Schizachyrium tenerum Nees, (**U**) *MM 4696, 4782; LB 19508*

Setaria parviflora (Poir.) Kerguelen, (**U**) DS

Sporobolus junceus (Beauv.) Kunth, (**U**) *DS; MM 4773; LB 26356*

Steinchisma hians (Ell.) Nash, (**U**) *MM 4398, 4941*

Tridens ambiguus (Ell.) J.A. Schultes, (**U,W**) *GW 2208; DS; MM 4760; LB 25562,*
Tridens strictus (Nutt.) Nash, (**W**) *GW 2193; LB 5577* [RICE]; *MM 4792, 4806*
Tripsacum dactyloides (L.) L., (**U**) *DS; MM 4459*

POLEMONIACEAE
Phlox pilosa L., (**U**) DS

POLYGALACEAE
Polygala cruciata L., (**W**) *GW 353*; DS
Polygala incarnata L., (**U,W**) *GW 3385; DS; MM 4276; LB 19233*
Polygala mariana P.Mill., (**U,W**) *DS; MM 4278, 4530*
Polygala polygama Walt., (**U**) DS
Polygala ramosa Ell., (**W**) *DS; MM 4405*

POLYGONACEAE
Polygonum punctatum Ell., (**P**) *LB 26372*

PRIMULACEAE
Anagallis minima (L.) Krause, (**U**) *MM 4895*

RANUNCULACEAE
Delphinium carolinianum Walt., (**U**) *MM 4496*

RHAMNACEAE
Berchemia scandens (Hill) K. Koch, (**U**) *MM 4829*
Frangula caroliniana (Walt.) Gray, (**U**) *MM 4826*

ROSACEAE
Crataegus marshallii Egglest., (**U**) *GW 2301*
Crataegus opaca Hook. & Arn., (**B,P,W**) *GW 2305; MM 4135, 4136, 4890*
Crataegus spathulata Michx., (**B**) *MM 4949*
Photinia pyrifolia (Lam.) Robertson & Phipps, (**W**) *DS; MM 4148*
Prunus caroliniana (P. Mill.) Ait., (**U**) *LB 26353*
Prunus serotina Ehrh., (**U**) *MM 4187*
Pyrus calleryana* Dcne., (U**) *MM 4184*
Rubus argutus Link, (**U**) *GW 2299; MM 4867*
Rubus trivialis Michx., (**U**) *GW 2300; MM 4176*

RUBIACEAE
Cephalanthus occidentalis L., (**W,P**) *MM 4417, 4515*
Diodia teres Walt., (**U**) *DS; LB 26145*
Diodia virginiana L., (**W**) *MM 4542; LB 26133*
Galium pilosum Ait., (**U**) *MM 4437; LB 25153*
Hedyotis nigricans (Lam.) Fosberg, (**U**) *DS; MM 4498*
Houstonia pusilla Schoepf, (**U**) *MM 4177*
Mitchella repens L., (**U**) *MM 4853*
Oldenlandia boscii (DC.) Chapman, (**P**) *LB 19227, 25544, 25570*

SARRACENIACEAE
+*Sarracenia alata* Wood, (**W**) *MM 4175; McL*

SCROPHULARIACEAE
Agalinis fasciculata (Ell.) Raf., (**U**) DS
Agalinis oligophylla Pennell, (**U**) *GW 3448, 3455; MM 4769; LB 6603*
Agalinis purpurea (L.) Pennell, (**U**) *LB 26343, 26378*
Agalinis viridis (Small) Pennell, (**U**) *GW 3426*
Gratiola brevifolia Raf., (**U,W**) *DS; MM 4266*
Gratiola pilosa Michx., (**U**) *MM 4499*
Lindernia crustacea* (L.) F. Muell., (P**) *LB 26363*
Mecardonia acuminata (Walt.) Small, (**U,W**) *MM 4776*
Penstemon laxiflorus Pennell, (**U**) *DS; MM 4274*

SMILACACEAE
Smilax bona-nox L., (**U**) *PM 15*; DS
Smilax glauca Walt., (**W,U**) *DS; MM 4185; LB 19246*
Smilax laurifolia L., (**W,B**) *MM 4870*
Smilax pumila Walt., (**U**) *MM 4832*
Smilax rotundifolia L., (**U**) *MM 4903; LB 25160*
Smilax smallii Morong, (**U**) *DS; MM 4182, 4851*

SOLANACEAE
Solanum ptychanthum Dunal, (**U**) *LB 26155*

SYMPLOCACEAE
Symplocos tinctoria (L.) L'Her., (**U**) *MM 4171*

VERBENACEAE
Callicarpa americana L., (**U**) *MM 4445*

VIOLACEAE
Viola lanceolata L., (**W**) *MM 4174*
Viola palmata L., (**U**) *MM 4138, 4164, 4186*
Viola primulifolia L., (**W**) *MM 4144a, 4918*
Viola sagittata Ait., (**U**) *MM 4165*

VITACEAE
Parthenocissus quinquefolia (L.) Planch., (**U**) *MM 4860*
Vitis rotundifolia Michx., (**U**) *MM 4833*

XYRIDACEAE
Xyris ambigua Bey. ex Kunth, (**W**) *DS; MM 4703; McL; LB 26132*
Xyris baldwiniana J.A. Schultes, (**W**) *MM 4156, 4397, 4419; LB 25524a*
Xyris stricta Chapman var. *obscura* Kral, (**W**) *LB 25540, 26129*
Xyris torta Sm., (**W**) *DS; MM 4517; LB 18626a, 25527*

Notes:
Cuscuta sp. The specimen had no flowers or fruit.
Gymnopogon brevifolius. This is the third record for this species in Texas.
Lobelia reverchonii. We prefer to keep this a good species.
Sarracenia alata. This species was introduced to the Hickory Creek Unit by Geraldine Watson in the early 1970's. It occurs naturally in wetland pine savannas nearby.
Scleria baldwinii. This is the first pineywoods region record.

DISCUSSION

Our plant list numbers 401 taxa (385 native) for the Hickory Creek Unit. Previous plant lists (Watson 1982; Yu n.d.) numbered well over 500 taxa. Why the discrepancy? Three possibilities suggest themselves: 1) our list is only about 75 percent complete, 2) the Unit was much richer 25 years ago when the first lists were developed, and 3) previous lists are at least partly conjectural, being "padded" with taxa that could possibly be there but which have not actually been found there.

These possibilities are not mutually exclusive and, at the present time, it is impossible to fully assess them. However, some comments are apropos.

Before we began collecting, the documented plant list for the Hickory Creek Unit numbered about 190 taxa (Brown n.d.). We doubled the list in 17 field trips in 2000 and 2001. If the total number of taxa at Hickory Creek numbered 530—i.e., only about one third had previously been documented—one would expect that, at least at first, approximately two out of every three of our collections would have been an addition. This was not the case, and we actively avoided recollecting in many cases. Additionally, on the basis of the specimens collected from the Hickory Creek Unit in the 1970's and 1980's and reported by Watson (1982), there is no evidence that there then existed plant communities additional to those that occur there now that would account for the additional taxa. The same taxa collected by Streng and Watson in the 1970's were recollected in 2000–2001, and Watson's listed species do not signal other communities. Finally, aerial photographs, scientific literature, historical accounts, and reminiscences by "old timers" clearly do not place additional plant communities there. With only four communities represented, one would expect on the basis of typical community counts (75 to 125 taxa per community type with some overlap among communities) only 400 taxa. Consequently, while we have obviously not found every taxon that exists at the Hickory Creek Unit, we feel that our list of 401 taxa is over 90 percent complete.

There is some evidence to support the second hypothesis. The Hickory Creek Unit is severely fire suppressed and has lost much of its herbaceous layer (Streng & Harcombe 1982; McClung 1988; MacRoberts & MacRoberts 2000). Today there remain only small patches of the extensive pine savannas that were

previously there. Some taxa undoubtedly could have been lost or at least become very rare in the ensuing years. For example, we did not find several of the conspicuous orchids that had been collected in the 1970's. Nonetheless, it is unlikely that 125 taxa have been lost in that period.

The third hypothesis probably explains a good deal of the discrepancy. The Parks and Cory (1936) Big Thicket plant list was partly conjectural ("could possibly be there") (Cozine 1993) and there is no reason to suppose that the Watson (1982) list was not also partly conjectural. Many species on Watson's (1982) list do not occur in the area and were probably added either because of misidentification (both in the field and of herbarium specimens) or because of conjecture. Cases in point include *Eriocaulon koernickianum* Van Heurck & Muell.-Arg. (undoubtedly misidentified *Lachnocaulon anceps*) and *E. septangulare* With. (probably misidentified *E. decangulare*) (see Brown & Brown 1996).

Thus, while it is the case that our list is incomplete and that a few taxa may have been lost, most taxa that have grown in the Hickory Creek Unit during the past quarter century have been collected (probably 90+ percent). We believe that the Hickory Creek Unit has about 400 to 425 native taxa, far fewer than have been attributed to it.

ACKNOWLEDGMENTS

This study was supported in part by a Southwest Parks and Monuments Association Grant # 99-2: "Distribution of bogs and wetland pine savannas." Roy Zipp, U.S. Park Service, aided with the work. Brooke Wheeler, Paul Harcombe, and Sandi Elsik provided information about several specimens at Rice University. Monique Reed provided information about a specimen at TAMU. Justin Williams provided information about four specimens at SHST. Thanks to Jason Singhurst and Walter Holmes for their comments on the manuscript.

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BOOKS RECEIVED/NOTICES

Annotations and comments by Editor

Horticulture/Gardening

MAGNUS JOHNSON. 2001. **The Genus Clematis. Edited and Translated by Bengt Sundström.** (ISBN 91-631-1030-X, hbk.). Magnus Johnson Plantskola AB and Bengt Sundström, Bränningestrandsvägen 63, 151 39 SÖDERTÄLJE, Sweden. (Orders: 08-550 979 77; +468 550 970 77). $110.00, 896 pp, 24 gouaches, about 100 illustrations from classical literature and ink drawings by the author, about 170 color photos, 6 3/4" × 9 1/2".

This book is quite the summary of *Clematis*. It represents 60 years of knowledge as a botanist, landscape architect and nurseyman (Magnus Johnson) of clematis. The first part (**Clematis: a stimulant in the garden**) deals with history, horticultural aspects, and the cultivation and propagation of clematis. The second part (**Scientific description of Clematis**) covers scientific descriptions of clematis including many new names and new combinations. The third part addresses **Descriptions of sections species and cultivars.** If you grow or want to grow clematis then you will want this book.

PETER F. YEO. 2002. **Hardy Geraniums. Second Edition.** (ISBN 0-88192-541-1, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $34.95, 218 pp, 57 color photos, 151 line illustrations, 7 3/8" × 9 3/4".

From the Preface: "The expression 'hardy geraniums' is the favoured one in horticultural circles for distinguishing *Geranium* of the botanists from *Pelargonium*, and it therefore forms the title of this book." *Geranium* it is and nearly all *Geranium* species have some ornamental value according to the author. This is a comprehensive guide and one that is beautifully illustrated with fantastic color pictures. The b/w line drawings are exceptionally nice. Whether you are a botanist or geranium enthusiast you can't go wrong with this book

FR. JOHN L. FIALA. 1988 (paper back edition 2002). **Lilacs: The Genus Syringa.** (ISBN 0-88192-530-6, pbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $34.95, 372 pp, 395 color illustrations, 82 b/w photos, 22 line drawings, 3 charts, 1 bn/w photo, 2 keys, 1 map, 8 1/2" × 11".

A classic now in paper back. You can almost smell the lilac fragrance.

VASCULAR PLANTS OF THE MAPIMÍ BIOSPHERE RESERVE, MÉXICO: A CHECKLIST

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ABSTRACT

The Mapimí Biosphere Reserve is located at the boundaries of the Mexican states of Chihuahua, Coahuila, and Durango in the part central of the Chihuahuan Desert. It extends over 342,387 ha. within an endorreic basin locally known as the Bolsón de Mapimí. Elevation varies between 1000 and 1480 m. Weather is very arid mostly with summer rains, the average annual precipitation is 264 mm. Vegetation types are mostly xerophytic scrub and halophytic grassland.

The vascular flora is composed of approximately 71 families, 242 genera, 403 species and 426 taxa approximately. Families with the greatest diversity are Asteraceae, Poaceae, Cactaceae, and Fabaceae. Genera with the greatest number of species are *Sporobolus*, *Opuntia*, *Aristida*, and *Acacia*. I recorded 31 species endemic to the Chihuahuan Desert.

RESUMEN

La Reserva de la Biosfera de Mapimí, se ubica en el límite de unión de los estados de Chihuahua, Coahuila y Durango en la parte central del Desierto Chihuahuense, conforma una extensión aproximada de 342,387 ha y constituye una cuenca endorreica, denominada Bolsón de Mapimí. La altitud varía entre los 1000 y 1480 m, su clima es muy árido con lluvias en verano y la precipitación es de aproximadamente 264 mm anuales. Los tipos de vegetación se clasifican como matorral xerófilo y pastizal halófilo.

La flora está constituida de aproximadamente 71 familias, 242 géneros, 403 especies y 426 taxa. Las familias con mayor diversidad son Asteraceae, Poaceae, Cactaceae y Fabaceae. Los géneros *Sporobolus*, *Opuntia*, *Aristida* y *Acacia* son los que presentan el mayor número de especies. Se registran 31 especies endémicas al Desierto Chihuahuense.

INTRODUCTION

The Mapimí Biosphere Reserve is representative of the arid ecosystems of the Chihuahuan Desert (Martínez & Morello 1977; Halffter 1981). Geographically it is located at the boundaries of the Mexican states of Chihuahua, Coahuila, and Durango (Bartolino 1988), between 26º 29' and 26º 52' N latitude, and 103º 32' and 103º 58' W longitude (Fig. 1). It has an area of 342,387 ha and constitutes an endorreic basin where fresh water sediments, basalts, and rhyolites have accumulated until the Miocene. The Mapimí Biosphere Reserve is part of the Bolsón de Mapimí, and it includes the basins of Laguna de Patos, Laguna de Palomas, and part of Laguna del Rey. It is part of the Mapimí subprovince.

The climate is very arid with most rain falling mostly between July and

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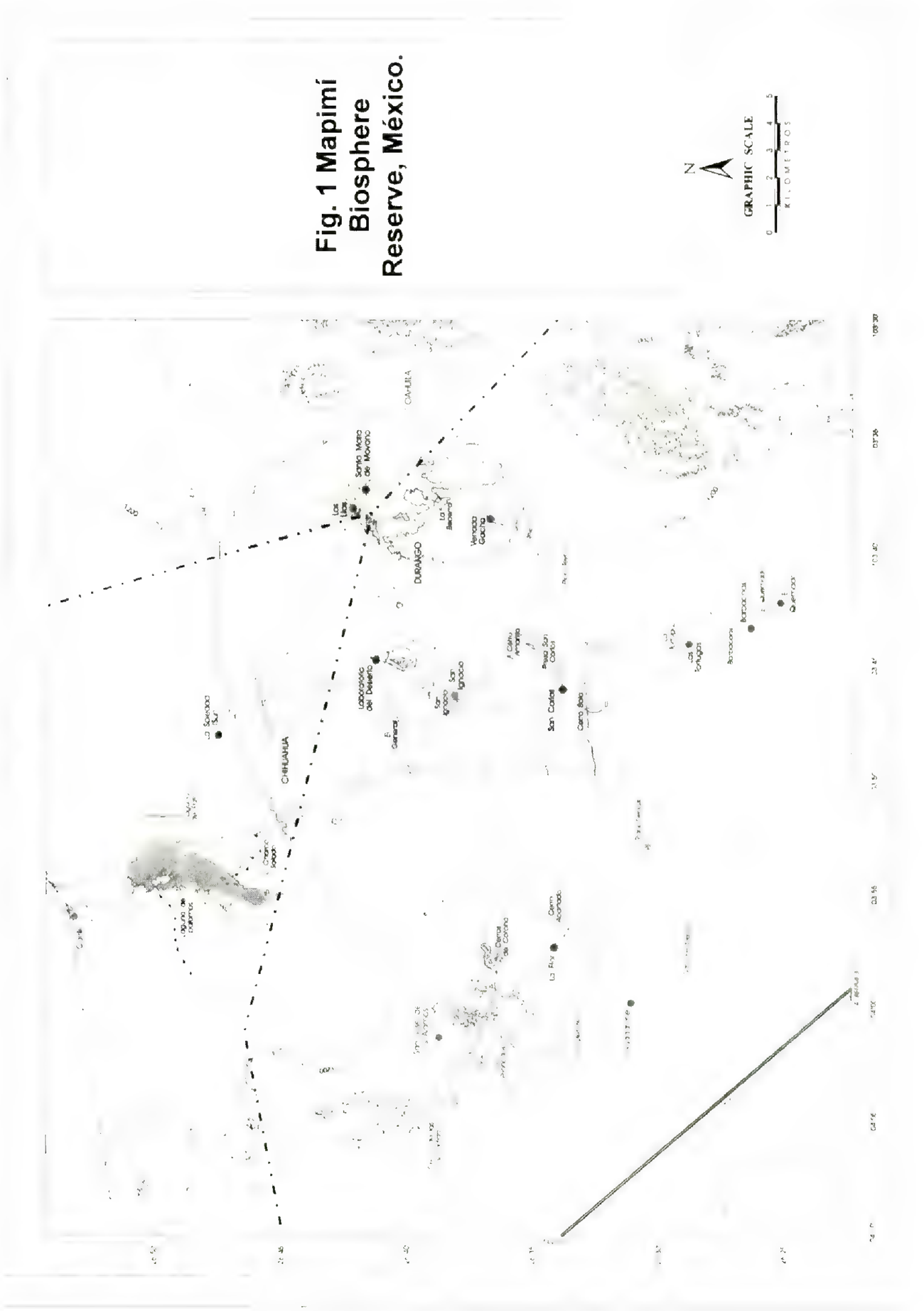


FIG. 1. Map showing location of Mapimí Biosphere Reserve in Mexico.

September. The average annual rainfall is 264 mm. The highest record is 513 mm and lowest is 81 mm, and a mean annual temperature of 20.8º. Elevation is about 1000 m at the lowest zones or "playas" and 1480 m at the summit of the Cerro San Ignacio, the highest point.

VEGETATION

Martínez and Morello (1977) described nine types of physionomic-floristic units for this region of the Mapimí. Later, González (1983) noted, on her description of the vegetation of Durango, desert xerophytic scrub, grasslands and halophytic vegetation as representative types for the region.

On the basis of the biological forms and dominant species, Montaña (1988) grouped vegetation into 76 associations. These associations were grouped into 14 categories of higher rank defined by combinations of dominant life forms. Out of the 35 species, 12 were more widely distributed as dominants: *Prosopis glandulosa* Torr., *Larrea tridentata* (DC.) Cov., *Hilaria mutica* (Buckley) Benth., *Fouqueria splendens* Engelm., *Acacia constricta* Benth., *Flourensia cernua* DC., *Cordia parvifolia* A. DC., *Atriplex acanthocarpa* (Torr.) S. Watson, *Acacia greggii* A. Gray, *Opuntia rastrera* F.A.C. Weber, *Dalea scoparia* A. Gray y *Yucca elata* Engelm.

In general, there are two dominant vegetation types, xerophytic scrub (Chihuahuan desert scrub) and halophytic grasslands, with a great diversity of associations.

Xerophytic scrub (Chihuahuan desert scrub).—This vegetation type is widely distributed in the reserve and is characterized by the dominance of shrubby species with a wide variety of plant associations. Species most commonly represented are: *Larrea tridentata, Prosopis glandulosa, Opuntia rastrera, Acacia constricta* and *Fouqueria splendens*, among others.

Halophytic grasslands.—Grasses are dominant in this vegetation type, and are found, mostly at places with high salt concentrations. Principle dominant species in the associations are *Sporobolus airoides* and *Pleuraphis mutica*.

FLORA

For the vascular flora of the Mapimí Biosphere Reserve 71 families, 242 genera, 403 species and 426 infraspecific taxa are registered. Families and genera with the greatest diversity are shown in Table 1. Endemic species to the Chihuahuan Desert are shown in Table 2. Previously, Ruiz de Esparza (1988) recorded 60 families, 197 genera and 313 species.

There are isolated collections from the Bolsón de Mapimí basin. In the 1980s these collections increased as it was the interest of various studies from Instituto de Ecología A.C. (Carlos Montaña, Antoine Cornet and Rosario Ruiz de Esparza). Recently, from 1994 on, García-Arévalo collected most of the specimens on which this catalogue is based.

Table 1. Most diverse families and genera.

Families	Species	Genera	Species
Asteraceae	68	*Sporobolus*	10
Poaceae	62	*Opuntia*	8
Cactaceae	29	*Aristida*	7
Fabaceae	21	*Acacia*	7

Table 2. Endemic species to the Chihuahuan Desert.

AMARANTHACEAE
Tidestromia suffruticosa (Torr.) Standl.

ASTERACEAE
Nicolletia edwardsii A. Gray
Pectis incisifolia I.M. Johnst.
Pectis pringlei Fernald
Psathyrotes scaposa A. Gray
Sartwellia puberula Rydb.
Viguiera brevifolia Greenm.
Viguiera phenax S.F. Blake

BORAGINACEAE
Tiquilia gossypina (Wooton & Standl.) A.T. Richardson
Tiquilia greggii (Torr. & A. Gray) A.T. Richardson

CACTACEAE
Ariocarpus fissuratus (Engelm.) K. Schum.
Coryphantha macromeris (Engelm.) Lem.
Echinocereus enneacanthus Engelm. var. *enneacanthus*
Echinomastus ungispinus (Engelm.) Britton & Rose
Mammillaria pottsii Scheer ex Salm-Dyck
Opuntia bradtiana (J.M.Coult.) K. Brandegee ex Salm-Dyck

CARYOPHYLLACEAE
Drymaria axillaris Brandegee

CONVOLVULACEAE
Bonamia multicaulis (Brandegee) House

FABACEAE
Senna pilosior (Robinson ex J.F.Macbr.) H.S. Irwin & Barneby

FOUQUERIACEAE
Fouqueria shrevei I.M. Johnst.

HYDROPHYLLACEAE
Nama stenophyllum A.Gray ex Hemsl.
Nama torynophyllum Greenm.

LAMIACEAE
Salvia purpusii Brandegee

LOASACEAE
Petalonix crenatus A. Gray ex S. Watson

NYCTAGINACEAE
Selinocarpus purpusianus Heimerl

POACEAE
Sporobolus coahuilensis Valdés-Reyna
Sporobolus spiciformis Swallen

POLYGONACEAE
Eriogonum hemipterum (Torr. & A Gray) S.G. Stokes

RUBIACEAE
Randia pringlei (S. Watson) A. Gray

ZYGOPHYLLACEAE
Fagonia scoparia Brandegee
Kallstroemia perennans B.L. Turner

To complement the catalogue, I reviewed the plant collections hosted at CIIDIR and ANSM, and also an unregistered herbarium hosted at Instituto de Ecología A.C., Centro Regional Durango. Plant specimens will be deposited at these collections.

CATALOGUE OF KNOWN VASCULAR PLANTS OF THE MAPIMI BIOSPHERE RESERVE (*NON-NATIVE SPECIES)

ACANTHACEAE

Justicia pilosella (Ness) R.A. Hilsenb.
Ruellia occidentalis (A. Gray) Tharp & F.A. Barkley

AGAVACEAE

Agave lechuguilla Torr.
Agave scabra Salm-Dyck ssp. *scabra*
Manfreda variegata (Jacobi) Rose

AIZOACEAE

Glinus lotoides L.
Sesuvium sessile Pers.

AMARANTHACEAE

Amaranthus arenicola I.M. Johnst.
Amaranthus palmeri S. Watson
Gomphrena decumbens Jacq.
Guilleminea lanuginosa (Poir.) Hook.f.
Iresine leptoclada (Hook.f.) Hen. & S.D. Sundb.
Tidestromia gemmata I.M. Johnst.
Tidestromia suffruticosa (Torr.) Standl.

AMARYLLIDACEAE

Zephyranthes longifolia Hemsl.

ANACARDIACEAE

Rhus microphylla Engelm.

APOCYNACEAE

Telosiphonia macrosiphon (Torr.) Henr.

ARISTOLOCHIACEAE

Aristolochia wrightii Seem.

ASCLEPIADACEAE

Asclepias brachystephana Engelm. ex Torr.
Asclepias linaria Cav.
Asclepias oenotheroides Cham. & Schltdl.
Asclepias viridiflora Raf.
Sarcostema crispum Benth.
Sarcostema cynanchoides Decne. subsp. *hartwegii* (Vail) R.W. Holm

ASTERACEAE= COMPOSITAE

Acourtia parryi (A. Gray) Reveal & R.M. King
Acourtia wrightii (A. Gray) Reveal & R.M. King
Ambrosia confertiflora DC.
Ambrosia psilostachya DC.
Artemisia filifolia Torr.
Aster spinosus Benth.
Aster subulatus Michx.
Baccharis salicifolia (Ruiz & Pavón.) Pers.
Bahia absinthifolia Benth.
Bahia biternata A. Gray
Baileya multiradiata Harv. & A. Gray
Barroetea subuligera (S. Schauer) A. Gray
Brickellia laciniata A. Gray
Brickellia coulteri A. Gray
Conyza coulteri A. Gray
Dicranocarpus parviflorus A. Gray
Eclipta postrata (L.) L.
Erigeron pubescens Kunth
Eupatorium solidagnifolium A. Gray
Flaveria palmeri J.R. Johnston
Flaveria trinervia (Spreng.) C. Mohr
Florestina tripteris DC.
Flourensia cernua DC.
Gaillardia pinnatifida Torr.
Gnaphalium falcatum Lam.
Grindelia oxylepis Greene
Gymnosperma glutinosum (Spreng.) Less.
Helenium autumnale L.
Helianthus ciliaris DC.
Helianthus petiolaris Nutt.
Iva ambrosiifolia (A. Gray) A. Gray
Iva dealbata A. Gray
Jefea brevifolia (A. Gray) Strother
Machaeranthera australis (Greene) Shinners
Machaeranthera brevilingulata (Hemsl.) B.L. Turner & D.B. Horne.
Machaeranthera linearis Greene
Machaeranthera pinnatifida (Hook.) Shinners
Nicolletia edwardsii A. Gray
Palafoxia sphacelata (Nutt. ex Torr.) Cory
Parthenium confertum A. Gray
Parthenium incanum H.B.K.
Pectis angustifolia Torr.
Pectis cylindrica (Fernald) Rydb.
Pectis incisifolia I.M. Johnst.
Pectis papposa Harv. & A. Gray
Pectis pringlei Fernald
Pectis tenella DC.
Porophyllum scoparium A. Gray
Psathyrotes scaposa A. Gray
Sanvitalia abertii A. Gray
Sanvitalia ocymoides DC.
Sartwellia puberula Rydb.
Simsia lagasciformis DC.
**Sonchus asper* (L.) Hill.
**Sonchus oleraceus* L.

Thymophylla aurea Greene var. *polychaeta* (A. Gray) J.L. Strother
Thymophylla pentachaeta Small
Trixis californica Kellogg var. californica
Verbesina encelioides (Cav.) Benth & Hooker
Viguiera brevifolia Greenm.
Viguiera cordifolia A. Gray
Viguiera dentata (Cav.) Spreng.
Viguiera multiflora (Nutt.) S.F. Blake
Viguiera phenax S.F. Blake
Viguiera stenoloba S.F. Blake
Xanthium strumarium L.
Xylothamia triantha (S.F. Blake) G.L. Nesom
Zinnia acerosa A. Gray

BIGNONIACEAE
Chilopsis linearis (Cav.) Sweet subsp. linearis
Tecoma stans (L.) H.B.K. var. *angustata* Rehd.

BORAGINACEAE
Antiphytum heliotropioides DC.
Tiquilia gossypina (Wooton & Standl.) A.T. Richardson
Tiquilia greggii (Torr. & A. Gray) A.T. Richardson
Tiquilia hispidissima (Torr. & A. Gray) A.T. Richardson
Cordia parvifolia DC.
Cryptantha pusilla (Torr. & A. Gray) Greene
Heliotropium convolvulaceum (Nutt.) A. Gray
Heliotropium curassavicum L. var. *curassavicum*
Heliotropium glabriusculum (Torr.) A. Gray
Heliotropium greggii Torr.
Heliotropium molle (Torr.) I.M. Johnst.

BROMELIACEAE
Hechtia glomerata Zucc.

BUDDLEJACEAE
Buddleja marrubiifolia Benth.
Buddleja scordioides H.B.K.

CACTACEAE
Ancistrocactus uncinatus (Galeotti) L.D. Benson
Ariocarpus fissuratus (Engelm.) K. Schum.
Coryphantha cornifera (DC.) Lem.
Coryphantha macromeris (Engelm.) Lem.
Coryphantha scheeri (Muhlenpf.) L.D. Benson var. *robustispina* (Schott ex Engelm.) L.D. Benson
Echinocactus horizonthalonius Lemaire
Echinocactus texensis Hopffer ex Regel
Echinocereus enneacanthus Engelm. var. *enneacanthus*
Echinocereus pectinatus (Scheidw.) Engelm. var. *rigidissimus* (Engelm.) Engelm. ex Rümpler
Echinomastus durangensis (Ruenge) Britton & Rose
Echinomastus ungispinus (Engelm.) Britton & Rose
Epithelantha micromeris (Engelm.) F.A.C. Weber
Escobaria tuberculosa (Engelm.) Britton & Rose
Hamatocactus hamatacanthus (Muhlenpf.) F.M. Knuth
Lophophora williamsii (Lem.) J.M. Coult.
Mammillaria heyderi Muehlenfordt var. *gummifera* (Engelm.) L.D. Benson
Mammillaria heyderi Muehlenpfordt var. *heyderi*
Mammillaria lasiacantha Engelm.
Mammilaria pottsii Scheer
Opuntia bradtiana (J.M. Coult. ex Salm Dyck) K. Brandegee
Opuntia imbricata (Haw.) DC.
Opuntia leptocaulis DC. var. *brevispina* (Engelm.) S. Watson
Opuntia leptocaulis DC. var. *robustior* A. Berger
Opuntia macrocentra Engelm.
Opuntia microdasys (Lehm.) Pfeiff.
Opuntia rastrera F.A.C. Weber
Opuntia schottii Engelm.
Peniocereus greggii (Engelm.) Britton & Rose var. greggii
Thelocactus bicolor (Galeotti ex Pfeiff.) Britton & Rose

CAPPARIDACEAE
Polanisia dodecandra (L.) DC.

CARYOPHYLLACEAE
Drymaria axillaris Brandegee
Drymaria molluginea (Ser. ex DC.) Didr.
Drymaria pachyphylla Wooton & Standl.

COCHLOSPERMACEAE
Amoreuxia wrightii A. Gray

COMMELINACEAE
Commelina erecta L.
Commelina erecta L. var. *angustifolia* (Michx.) Fernald

CONVOLVULACEAE
Bonamia multicaulis (Brandegee) House
Cressa truxillensis H.B.K. var. *vallicola* (A. Heller) Munz
Cuscuta umbellata Kunth
Ipomoea costellata Torr.
Ipomoea cristulata Hallier f.
Ipomoea purpurea (L.) Roth

CRUCIFERAE
Descurainia pinnata (Walter) Britt.
Dimorphocarpa wislizenii (Engelm.) Rollins
**Eruca versicaria* (L.) Cav. subsp. sativa (Miller) Thell.
Nerisyrenia camporum (A. Gray) Greene
Nerisyrenia linearifolia (S. Watson) Greene
**Sisymbrium irio* L.
Stanleya pinnata (Pursh) Britton

CUCURBITACEAE
Apodanthera undulata A. Gray
Ibervillea tenuisecta (A. Gray) Small

CYPERACEAE
Cyperus aff. *odoratus* L.
Eleocharis caribaea (Rottb.) S.F. Blake
Eleocharis macrostachya Britton
Eleocharis parvula (Roem. & Schult.) Link ex Bluff, Nees & Schauer
Scirpus maritimus L.

CHENOPODIACEAE
Allenrolfea occidentalis (S. Watson) O. Kuntze
Atriplex acanthocarpa (Torr.) S. Watson
Atriplex canescens (Pursh) Nutt.
Atriplex obovata Moq.
Chenopodium glaucum L.
**Salsola tragus* L.
Suaeda nigrescens I.M. Johnst.
Suaeda suffrutescens S. Watson

EPHEDRACEAE
Ephedra trifurca Torr. ex S. Watson

EUPHORBIACEAE
Acalypha monostachya Cav.
Croton pottsii (Klotch) Muell.-Arg.
Ditaxis neomexicana (Muell.-Arg.) A. Heller
Euphorbia antisyphilitica Zucc.
Euphorbia dentata Michx.
Euphorbia prostrata Aiton
Euphorbia strictior Holz.
Jatropha dioica Cerv.
Tetraccocus fasciculatus (S. Watson) Croizat
Tragia nepetifolia Cav.

FABACEAE=LEGUMINOSAE
Acacia angustissima (Mill.) O. Kuntze
Acacia berlandieri Benth.
Acacia constricta Benth.
Acacia farnesiana (L.) Willd
Acacia greggii A. Gray
Acacia neovernicosa Isely
Acacia roemeriana Scheele
Dalea aurea Nutt. ex Fraser
Dalea lanata Spreng.
Dalea leporina (Aiton) Bullock
Dalea neomexicana (A. Gray) Cory
Dalea pogonathera A. Gray
Dalea scoparia A. Gray
Desmodium neomexicanum A. Gray
Hoffmansegia glauca (Ort.) Eifert
**Parkinsonia aculeata* L.
Phaseolus polymorphus S. Watson
Prosopis glandulosa Torr. var. *torreyana* (L.D. Benson) M.C. Johnst.
Senna bahuinioides (A. Gray) H.S. Irwin & Barneby
Senna covesii (A. Gray) H.S. Irwin & Barneby
Senna pilosior (Robinson & Macbride) H.S. Irwin & Barneby

FOUQUERIACEAE
Fouqueria shrevei I.M. Johnst.
Fouqueria splendens Engelm.

GENTIANACEAE
Centaurium calycosum (Buckley) Fernald

HYDROPHYLLACEAE
Nama parvifolium (Torr.) Greenm.
Nama stenocarpum A. Gray
Nama stenophyllum A. Gray ex Hemsl.
Nama torynophyllum Greenm.
Nama xylopodum (Wooton. & Standl.) C.L. Hitchc.
Phacelia congesta Hook.

KOEBERLINIACEAE
Koeberlinia spinosa Zucc.

KRAMERIACEAE
Krameria glandulosa Rose & Painter
Krameria erecta Willd ex Schult.

LAMIACEAE=LABIATAE
Salazaria mexicana Torr.
Salvia purpusii Brandegee
Salvia reflexa Hornem.
Teucrium cubense Jacq.

LILIACEAE
Dasylirion wheeleri S. Watson ex Rothr.
Milla biflora Cav.
Yucca elata Engelm.
Yucca rigida (Engelm.) Trel.
Yucca torreyi Shafer

LOASACEAE
Cevallia sinuata Lag.

Eucnide bartonioides Zucc.
Mentzelia albicaulis (Hook.) Torr. & A. Gray
Mentzelia pumila (Nutt.) Torr. & A. Gray
Petalonix crenatus A. Gray ex S. Watson

LORANTHACEAE
Phoradendron tomentosum (DC.) Engelm. ex A. Gray subsp. *tomentosum*

LYTHRACEAE
Ammannia coccinea Rottb.

MALPIGHIACEAE
Janusia gracilis A. Gray

MALVACEAE
Abutilon malacum S. Watson
Anoda pentaschista A. Gray
Hibiscus coulteri Harv. ex A. Gray
Hibiscus denudatus Benth.
Malva parviflora L.
Malvastrum coromandelianum (L.) Garcke
Malvella lepidota (A. Gray) Fryxell
Malvella leprosa (Ortega) Krapov.
Malvella sagitiifolia (A. Gray) Fryxell
Sida abutifolia Miller
Sphaeralcea angustifolia (Cav.) G. Don
Sphaeralcea hastulata A. Gray

MARTYNIACEAE
Proboscidea althaefolia Decne.
Proboscidea fragans (Lindl.) Decne.

MELIACEAE
**Melia azedarach* L.

NYCTAGINACEAE
Acleisanthes longiflora A. Gray
Allionia choisyi Standl.
Allionia incarnata L.
Anulocaulis eriosolenus Standl.
Boerhavia gracillima Heimerl
Boerhavia intermedia M.E. Jones
Boerhavia spicata Choisy
Boerhavia wrightii A. Gray
Mirabilis rotata (Standl.) I.M. Johnst.
Mirabilis viscosa Cav.
Nyctaginia capitata Choisy
Selinocarpus angustifolius Torr.
Selinocarpus purpusianus Heimerl

OLEACEAE
Forestiera angustifolia Torr.
Menodora scabra A. Gray

ONAGRACEAE
Clarkia purpurea (Curt.) A. Nelson & I.F. Macbr. subsp. *quadrivulnera* (Douglas) F.H. Lewis & M.R. Lewis
Oenothera aff. *texensis* P.H. Raven & D.R. Parnel
Oenothera speciosa Nutt.

OROBANCHACEAE
Orobanche cooperi (A. Gray) Heller

OXALIDACEAE
Oxalis aff. *decaphylla* Kunth
Oxalis L.

PALMAE
**Washingtonia filifera* (Linden ex André) H. Wendl.

PAPAVARACEAE
Argemone ochroleuca Sweet

POACEAE= GRAMINEAE
Aristida adscencionis L.
Aristida fendleriana Steud.
Aristida pansa Wooton & Standl.
Aristida purpurea Nutt. var. nealleyi (Vasey) Allred
Aristida roemeriana Scheele
Aristida ternipes Cav.
Aristida wrightii Nash
Bouteloua aristidoides (Kunth) Griseb.
Bouteloua barbata Lag.
Bouteloua curtipendula (Michx.) Torr.
Bouteloua ramosa Vasey
Bouteloua repens (H.B.K.) Scribn. & Merr.
Bouteloua uniflora Vasey
Brachiaria arizonica (Scribner & Merrill) S.T. Blake
Brachiaria fasciculata (Sw.) Parodi
Chloris crinita Lag.
Chloris virgata Sw.
Cottea pappophoroides Kunth
**Cynodon dactylon* (L.) Pers.
Digitaria californica (Benth.) Henrard
**Echinochloa colonum* (L.) Link
Echinochloa muricata (P. Beauv.) Fernald
Enneapogon desvauxii P. Beauv.
Eragrostis barrelieri Daveau
**Eragrostis cilianensis* (All.) Vignolo ex Janch.
Eragrostis mexicana (Hornem.) Link
Eragrostis pilosa (L.) Beauv.
Eriochloa acuminata (I. Presl) Kunth
Eriochloa contracta Hitchc.

Erioneuron pulchellum (Kunth) Tateoka
Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult.
Leptochloa dubia (H.B.K.) Nees
Leptochloa fascicularis (Lam.) Beauv.
Muhlenbergia arenicola Buckley
Muhlenbergia fragilis Swallen
Muhlenbergia porteri Scribn. ex Beal
Panicum flexile (Gatt.) Scribn.
Panicum hallii Vasey
Panicum hirticaule J. Presl
Panicum obtusum Kunth
Panicum stramineum Hitchc. & Chase
Pappophorum mucronulatum Ness
**Pennisetum ciliare* (L.) Link
Phragmites australis (Cav.) Trin. ex Steud.
Pleuraphis mutica Buckley
Scleropogon brevifolius Phil.
Setaria adhaerens (Forssk.) Chiov.
Setaria grisebachii E. Fourn.
Setaria scheelei (Steud.) Hitchc.
Sporobolus airoides (Torr.) Torr.
Sporobolus coahuilensis Valdés-Reyna
Sporobolus contractus Hitchc.
Sporobolus coromandelianus (Retz.) Kunth
Sporobolus cryptandrus (Torr.) A. Gray
Sporobolus flexuosus (Thurb. ex Vasey) Rydb.
Sporobolus patens Swallen
Sporobolus poiretii (Roem. & Schult.) Hitchc.
Sporobolus spiciformis Swallen
Sporobolus teretifolius R.M. Harper
Tragus berteronianus Schult.
Tridens albescens (Vasey) Wooton. & Standl.
Tridens muticus (Torr.) Nash

POLEMONIACEAE
Ipomopsis laxiflora (I.M. Coult.) V.E. Grant
Ipomopsis longiflora (Torr.) V.E. Grant
Ipomopsis polycladon (Torr.) V.E. Grant

POLYGALACEAE
Polygala obscura Benth.

POLYGONACEAE
Eriogonum hemipterum (Torr. & A. Gray) S. Stokes
**Polygonum aviculare* L.
Polygonum pensylvanicum L.
Rumex verticillatus L.

PORTULACACEAE
Portulaca oleracea L.
Talinopsis frutescens A. Gray
Talinum aurantiacum Engelm.
Talinum paniculatum (Jacq.) Gaertn.

POTAMOGETONACEAE
Potamogeton nodosus Poir.

PRIMULACEAE
Samolus ebracteatus Kunth

PTERIDACEAE
Astrolepis cochisensis (Goodd.) Benham & Windham
Astrolepis sinuata (Sw.) Benham & Windham
Notholaena standleyi Maxon

RANUNCULACEAE
Clematis drummondii Torr. & A. Gray

RESEDACEAE
Oligomeris linifolia (Vahl) J.F. Macbr.

RHAMNACEAE
Condalia warnockii M. C. Johnst.
Ziziphus obtusifolia (Hook. ex Torr. & A. Gray.) A. Gray

RUBIACEAE
Randia pringlei (S. Watson) A. Gray

RUTACEAE
Thamnosma texana (A. Gray) Torr.

SALICACEAE
Salix exigua Nutt.

SCROPHULARIACEAE
Castilleja integra A. Gray
Leucophyllum laevigatum Standl.
Leucophyllum minus A. Gray
Maurandya antirrhiniflora Humb. & Bonpl. ex Willd.
Mecardonia procumbens (Miller) Small
Stemodia schottii Holz.

SELAGINELLACEAE
Selaginella lepidophylla (Hook. & Grev.) Spring

SIMAROUBACEAE
Castela texana (Torr. & A. Gray) Rose

SOLANACEAE
Calibrachoa parviflora (Juss.) D´Arcy
Chamaesaracha conioides (Dunal) Britton
Datura ceratocaula Ortega
Datura inoxia Mill.
Datura quercifolia Kunth
Lycium berlandieri M. Dunal
**Nicotiana glauca* R. Graham

Nicotiana obtusifolia Mart. & Gal
Physalis cinerascens (Dunal) Hitchc.
Physalis hederifolia A. Gray
Physalis aff. *microphysa* A. Gray
Quincula lobata (Torr.) Raf.
Solanum citrullifolium A. Braun
Solanum eleagnifolium Cav.
Solanum rostratum M. Dunal
Solanum triquetrum Cav.

TAMARICACEAE
**Tamarix ramosissima* Ledeb.

ULMACEAE
Celtis pallida Torr.

VERBENACEAE
Aloysia gratissima (Gillies & Hook.) Tronc.
Aloysia gratissima (Gillies & Hook.) Tronc. var. *schulzae* (Standl.) Mold.
Aloysia wrightii (A. Gray) A. Heller ex Abrams
Bouchea prismatica (L.) K. E. O. Kuntze
Citharexylum brachyanthum (A. Gray) A. Gray
Glandularia bipinnatifida (Nutt.) Nutt.
Lantana achyranthifolia Desf.
Lippia graveolens Kunth
Phyla incisa Small
Phyla nodiflora (L.) Greene
Phyla strigulosa (M. Martens & Galeotti) Moldenke
Verbena canescens Kunth
Verbena gracilis Desf.

VITACEAE
Cissus trifoliata L.

ZYGOPHYLLACEAE
Fagonia scoparia Brandegee
Kallstroemia grandiflora Torr. ex A. Gray
Kallstroemia hirsutissima Vail
Kallstroemia perennans B.L. Turner
Larrea tridentata (Sessé & Moc. ex DC.) Coville
Peganum aff. *mexicanum* A. Gray
**Tribulus terrestris* L.

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BOOKS RECEIVED/NOTICES

Annotations and comments by Editor

Horticulture/Gardening

HAROLD KOOPOWITZ. 2002. **Clivias.** (ISBN 0-88192-546-2, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $34.95, 384 pp, 118 color illustrations, 3 charts, 1 bn/w photo, 2 keys, 1 map, 6" × 9".

Clivia is a small genus (four species) in Amaryllidaceae family from southern Africa. "They are all evergreen herbs with leaves arranged in two rank borne on a thick rhizome." The name honors Lady Charlotte Florentia Clive. "Clivias is the first practical book on this fascinating genus. The result is a comprehensive treatment that covers the history and biology of clivias, and provides profuse information on cultivation, color, and breeding." There are 118 great color photographs. **Contents:** Introduction, What is in a Name?; *Clivia* and *Cryptostephanus*: The Species; The Biology of a Clivia Plant; Cultivating and Growing Clivias; Understanding Clivia Colors; Hybridizing and Growing Clivias from Seed; Clivia Obsession; Standard *Clivia miniata* Hybrids: Orange and Red; Standard *Clivia miniata* Hybrids: Yellow; Standard *Clivia miniata* Hybrids: Pastel Colors; Variegated Clivias; Cyrtanthiflora-type Clivias and Related Hybrids; Novelty Clivias; The Future; Appendix I. Who Was Lady Clive?; Appendix II. Sources of Information; Appendix III. Sources of Plants; Glossary; Map of South Africa; References and Additional Reading; Index of Plant Names.

LEWIS J. MATTHEWS. 2002. **The Protea Book: A Guide to Cultivated Proteaceae.** (ISBN 0-88192-553-5, pbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $34.95, 184 pp, 286 color photos, 7 1/4" × 10 1/4".

"Proteaceae is a large and ancient family of incredible diversity in both foliage and flower form. In recognition of this variety, Linnaeus named them after the legendary Greek sea god Proteus, who could change his shape at will." This is a must book for anyone interested in Proteas. Whether you are a grower or the cut-flower industry you will like this book. **Contents:** Introduction; Cultivating proteas; Proteas in the garden; Commercial cultivation; Identification; Glossary; References; Index.

MICHAEL A. DIRR. 2002. **Dirr's Trees and Shrubs for Warm Climates: An Illustrated Encyclopedia.** (ISBN 0-88192-525-X, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $69.95, 448 pp, 1438 color photos, 1 map, 8 1/2" × 11".

This is a companion volume to *Dirr's Hardy Trees and Shrubs: An Illustrated Encyclopedia* also published by Timber Press. This is truly an encyclopedia of beauty and detail for more than 400 species and nearly 500 additional cultivars and varieties, many of which are illustrated. Even if you are not into woody plants this book will surely please you. The 1438 color photos are worth the price alone.

A SIGNIFICANT NEW POPULATION OF THE RARE SEMAPHORE PRICKLYPEAR CACTUS, *OPUNTIA CORALLICOLA* (CACTACEAE)

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ABSTRACT

A newly discovered population of *Opuntia corallicola* is reported. This new population is in Miami-Dade County, Florida, 145 km north of what was believed to be the last remaining population in the wild.

RESUMEN

Se informa de una población recientemente descubierta de Opuntia corallicola. Esta nueva población está en el Condado Miami-Dade, Florida, 145 km al norte de lo que se pensaba que era la última población que crecía silvestre en la naturaleza.

The semaphore pricklypear cactus, *Opuntia corallicola* (Small) Werderm. (Cactaceae) is considered one of the most threatened plants in the United States (Stiling et al. 2000). It is endemic to the Florida Keys, first discovered by John Kunkel Small in 1919 (Small 1930). Previously, Florida plants were thought to be conspecific with *O. spinosissima* P. Miller of Jamaica, but research has shown Florida plants to be distinct (Austin et al. 1998; Gordon & Kubisiak 1998). The Florida Keys are a chain of islands at the southern tip of Florida, extending in an arc approximately 320 km from the Dry Tortugas in Monroe County north to Soldier Key in Miami-Dade County.

Small's discovery of *O. corallicola* was made on Big Pine Key, an island in the lower Florida Keys. Plants were known from this island until the 1960s when the last plants were eliminated by poaching and road construction. Sometime during the 1960s a new population was discovered on Little Torch Key, an island immediately west of Big Pine Key. Subsequently, the station was acquired by The Nature Conservancy. Small (1930) also reported the species from Key Largo, an island in the upper Florida Keys just over 80 km north of Big Pine Key, although we have been unable to locate specimens or other reports from this island.

The population on Little Torch Key presently has only nine adult plants (C. Bergh, pers. comm.). Plants at this site are threatened, originally by poaching, and subsequently by both an exotic moth and its inability to sexually reproduce. The exotic moth, *Cactoblastis cactorum* Berg (Lepidoptera: Pyralidae),

was discovered in the Florida Keys in 1989 (Habeck & Bennett 1990). This pest infested two of the remaining wild plants, killing one of them (Stiling & Moon 2001). While vegetative reproduction results in numerous recruits (C. Bergh, pers. comm.), Negrón-Ortiz (1998) found that fruit set in the species is rare. Less than half of the seeds set were viable in laboratory culture, but no seedling recruitment was found under natural conditions. The few seeds produced are believed to result from agamospermy, asexual seed formation common in Cactaceae (Negrón-Ortiz 1998). Negrón-Ortiz (1998) proposed that the species is unable to reproduce sexually either because of meiotic problems resulting from polyploidy, or because the existing plants are self-incompatible.

The authors and George D. Gann have been conducting extensive field work in Biscayne National Park (BNP) in part to update the floristic inventory published by Stalter et al. (1999). The park is comprised of 42 islands of the upper Florida Keys in Miami-Dade County. On November 20, 2001, the authors discovered *O. corallicola* on Swan Key. This island is within the southern boundary of BNP and is approximately 140 km from Big Pine Key, the closest historically documented occurrence, and 145 km from Little Torch Key, the site of the other known population. On January 31, 2002 a subsequent survey was conducted and 570 plants with trunks were found. The population consisted of plants of diverse sizes and ages, including flowering individuals.

The new Swan Key population occupied approximately 0.5 km by 10 m along the edge of a rockland hammock. Plants were in partial sun to shade growing on Key Largo Limestone, sometimes in light leaf litter and duff. While plants were found primarily along the edges of the hammock, some small plants were found inside the shady interior of the hammock up to 50 m from the edge. Associated plant species include *Acanthocereus tetragonus, Agave decipiens, Borrichia arborescens, Bursera simaruba, Canella winterana, Capparis flexuosa, Coccoloba diversifolia, Conocarpus erectus, Eugenia foetida, Guapira discolor, Metopium toxiferum, Pithecellobium keyense,* and *Sideroxylon celastrinum.*

We believe that *O. corallicola* merits Federal Endangered Species status. Even with the discovery of this new population, only two populations of this species are known. Both populations are threatened by *Cactoblastis cactorum. Opuntia corallicola* is being considered by the U.S. Fish and Wildlife Service as a candidate for listing (Federal Register 1999; Bradley & Gann 1999). Endangered Species status would enable the National Park Service to focus on the management and protection of the species. We encourage the U.S. Fish and Wildlife Service to continue with the listing process and we support the establishment of an agreement with the National Park Service to focus on the management and protection of the species.

Voucher specimen: **FLORIDA. Miami-Dade Co.:** Biscayne National Park; Swan Key, between Old Rhodes Channel and Broad Creek, S of Old Rhodes Key, just N of the Monroe Co. line, common along the edge of rockland hammock, 31 Jan 2002, *Bradley* 2152 (FTG).

ACKNOWLEDGMENTS

The BNP inventory was funded through the National Park Service (NPS) Inventory and Monitoring Program, as part of the South Florida / Caribbean Network of Parks Inventory of Vertebrates and Vascular Plants. We would like to thank NPS ecologist Matt Patterson and NPS biologist Toby Obenauer. Fairchild Tropical Garden (FTG) provided funding for the follow up survey which was conducted with FTG biologists Meghan Fellows and Jennifer Possley. Robert Pemberton, entomologist for U.S. Department of Agriculture–Agricultural Research Service, also assisted with the follow-up survey. George Gann, Doria Gordon, Dawn Jennings, Colette Jacono, and an anonymous reviewer provided helpful comments on the manuscript.

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Horticulture/Gardening

FRANCIS HALLÉ. Translated and with foreword by DAVID LEE. 2002. **In Praise of Plants.** (ISBN 0-88192-550-0, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $24.95, hbk., 334 pp., 99 line drawings, 6" × 9".

Contents.—**Chapter 1.** Plants, Animals, and Humans. **Chapter 2.** A Visit to the Landscape of Form. **Chapter 3.** The Cell. **Chapter 4.** Plant Biochemistry in a Nutshell. **Chapter 5.** Evolution. **Chapter 6**. Of Other Living Beings. **Chapter 7.** Ecology. The book concludes with an Epilogue, References, and Index. This is a book that invites you to look closer at the world of plants and animals around us. The first chapter contains a section on "*Comparing Plants and Animals*" and the closing paragraph will give you a taste of what is to come. "What are plants? Despite the important place they occupy in our landscapes, they are often ignored or scorned by modern biologists, by loggers, and the old foresters, by people in general. Does that place us on a contrasting quest to understand plants? Plants please most women, they pleased Christ and the Buddha, the last emperor of China, the scholars of earlier centuries, and they have pleased innumerable artists and philosophers, including Goethe, Cioran, Colette, Valéry, Mandela, Dürer, Giono, Hugo, and Rilke. First what do plants resemble and how can we comprehend the forms they have adopted."

ALLAN M. ARMITAGE. 2001. **Armitage's Manual of Annuals, Biennals, and Half-Hardy Perennials.** (ISBN 0-88192-505-5, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $39.95, hbk., 604 pp., 125 color photos, 107 line drawings, 1 map, 75 tables, 6" × 9".

EMILY S. SIEGERIST. 2001. **Bulbophyllums and Their Allies: A Grower's Guide.** (ISBN 0-88192-506-3, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $34.95, hbk., 284 pp., 77 color photos, 6" × 9".

JIM COOTES. 2001. **Orchids of the Philippines.** (ISBN 0-88192-516-0, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $49.95, hbk., 232 pp., 339 color photos, 1 diagram, 1 map, 7 1/2" × 10".

PLANTS NEW TO THE UNITED STATES AND FLORIDA

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ABSTRACT

Eight taxa are reported as new to continental United States and the state of Florida: *Alstonia scholaris*, *Bromelia pinguin*, *Costus pulverulentus*, *Enydra fluctuans*, *Eucalyptus torelliana*, *Hygrophila difformis*, *Khaya senegalensis*, and *Oxalis triangularis* var. *papilionacea*. The reports for the non-native *Berberis bealei* and *Canna glauca* and the native *Rudbeckia auriculata* are the first for Florida. The occurrence of *Didiplis diandra* in Florida is verified.

RESUMEN

Se citan ocho taxa como nuevos para los Estados Unidos continentales y el estado de Florida: *Alstonia scholaris*, *Bromelia pinguin*, *Costus pulverulentus*, *Enydra fluctuans*, Eucalyptus torelliana, Hygrophila difformis, Khaya senegalensis, y Oxalis triangularis var. papilionacea. Las citas de las no nativas *Berberis bealei* y *Canna glauca* junto con la autóctona *Rudbeckia auriculata* son las primeras para Florida. Se verifica la existencia de *Didiplis diandra* en Florida.

Continuing study on the flora of Florida and for the *Guide to the Vascular Plants of Florida, Second Edition* (Wunderlin & Hansen, in press) has resulted in 12 taxa new to the state. Eight of these, all introduced, also likely represent new records for the continental United States. Three additional species, two introduced and one native, are new records for Florida, and the occurrence of *Didiplis diandra* is verified for the state. This paper emphasizes the potential for more natives to be discovered in Florida, as well as the high probability for invasion by exotics. Of the over 4,119 taxa of plants in Florida, 1,305 (32%) are non-native (Wunderlin & Hansen 2002). The criteria for including plants in the flora follow that of Wunderlin and Hansen (2000, p. 4).

SPECIES NEW TO CONTINENTAL UNITED STATES AND FLORIDA

Alstonia scholaris (L.) R.Br.—Palm Beach Co.: Village of Wellington, wetland preserve at Wellington Mall, T44S, R11E, Sec. 13, 22 Feb 2002, *Miller s.n.* (USF). Native to the Indo-Pacific area and occasionally cultivated in Florida, "dita" (or "white cheesewood") can be expected as an escape. The seeds are wind dispersed,

and the plant at Wellington Mall apparently became established from nearby plantings. It now has been eradicated from the site.

Bromelia pinguin L.—Hillsborough Co.: Riverside Park, Temple Terrace, 6 Dec 2001, *Dickman s.n.* (USF). Native to tropical America, "pinguin" is an escape from cultivation in central Florida.

Costus pulverulentus C. Presl—Orange Co.: Valencia Community College, East Campus, 700 block of North Econlockhatchee Trail, ca. 10 mi E of Orlando, T22S, R31E, Sec. 19, edge of riverine hammock, 1 Nov 2000, *Myers* 2 (USF). Seminole Co.: Sweetwater Park, 100 block of Magnolia Street, Oviedo, 28°40.668'N, 81°12.352'W, oak hammock, 2 Sep 2001, *Myers 290* (USF). Native to tropical America and escaped from cultivation in Orange and Seminole Counties.

Enydra fluctuans Lour.—Hillsborough Co.: Tampa, ditch along the E side of Manhattan Avenue just S of the intersection of Manhattan Avenue and Rembrandt Drive on the Interbay Peninsula, T30S, R18E, Sec. 16, 7 Apr 2000, *Shuey & Poyner s.n.* (USF). "Buffalo Spinach" is a pantropical aquatic plant, sometimes cultivated for use in Asiatic foods. It is potentially highly invasive, readily rooting from stem fragments.

Eucalyptus torelliana F. Muell.—Palm Beach Co: E of the intersection of Alternate A1A and Hood Road, Palm Beach Gardens, 14 Jun 2001, *Miller s.n.* (USF). "Torell's eucalyptus" or "cadaga" is native to Australia and escaped from cultivation in southern Florida. Trees and seedlings occur in a designated preserve, these apparently coming from a development north of the site (Frenchman's Creek) where this species is used in landscaping.

Hygrophila difformis (L.) Blume—Hillsborough Co.: spreading on clayey shelf of man-made pond on N side of Cherry Street, 0.7 mi W of park Road, Plant City, T28S, R22E, Sec. 21, SE $^1/_4$ of SW $^1/_4$, 5 May 1999, *Hansen & Wunderlin 12893* (USF). "Water wisteria," native to southeastern Asia, is often grown as an aquarium plant. The Hillsborough County plants probably originated as a discard from an aquarium and have now formed a sizable population in the pond. It easily propagates from stem fragments and has high invasive potential in lakes, ponds, and rivers. When growing out of the water, it is erect and flowers profusely. However, mature seeds were not observed by Hansen and Wunderlin.

Khaya senegalensis (Desr.) A. Juss.—Collier Co.: Collier Seminole State Park, Campsite #7 of 1–19, T51S, R27E, Sec 27, SE $^1/_4$, SW $^1/_4$, SE $^1/_4$, rockland hammock, 17 Apr 1998, *Hattaway CS0319* (USF). "African mahogany" is native to Africa and widely grown as a street and timber tree in the tropics (Irvine 1961). It has the potential to invade disturbed tropical forests. It is naturalized in Western Australia (Csurhes & Edwards 1998). The population in Collier-Seminole State Park consisted of several trees (one very large), but these have now been eradicated.

Oxalis triangularis A. St.-Hil. subsp. **papilionacea** (Hoffmanns. ex Zucc.)

Lourteig—Leon Co.: several plants naturalized in deeply shaded loam along roadside of Duparc Circle near its W junction with Lakeshore Drive, Tallahassee, 23 Feb 2001, *Anderson 19691* (FSU). "Purpleleaf false shamrock," native to South America, is occasionally cultivated in North America for its purple leaves. The Leon County site is the only location known where it is naturalized in North America.

SPECIES NEW TO FLORIDA

Berberis bealei Fortune—Leon Co.: naturalized single shrub (vegetative) in moist loam of deeply shaded creek swamp NNE of marker 20 in Elinor Klapp-Phipps Park, W of Meridian Rd, N of Tallahassee, T2N, R1W, Sec. 36, NW 1/4 of NW 1/4, 30 May 1996, *Anderson 16530* (FSU); flowering shrub in pine-oak woodland remnant on S side of Duparc Circle just N of Lakeshore Drive, Tallahassee, 23 Feb 2001, *Anderson 19688* (FSU). These two sites are about 1.6 miles apart. Naturalized in Delaware, Virginia, North Carolina, South Carolina, Georgia, and Alabama (USDA, NRCS 2002), "Beale's barberry" or "leatherleaf mahonia" is now reported from Florida. It is an evergreen shrub native to China and frequently cultivated outside its native range.

Canna glauca L.—Madison Co.: along US 90, Greenville, 29 July 1967, *Beckner 1885* (FLAS). The species is native to tropical America and previously known in the United States only from Louisiana and Texas where it is considered to be native (Kress & Prince 2000). It is escaped from cultivation at one site in Madison Co., Florida, where it occurs as frequent clumps around several burned-out houses near a lake where it is spreading vegetatively and by seed.

Didiplis diandra (Nutt. ex DC.) A.W. Wood—Sarasota Co.: Pinelands Reserve, ca. 1 mi SW of Lower Myakka Lake, T38S, R19E, Sec. 1, freshwater marsh, 6 Apr 1998, *Morrison 98064-1* (USF). "Waterpurslane," a submergent or emergent aquatic is apparently native from Minnesota and Wisconsin south to Georgia, Alabama, Mississippi, Louisiana, and Texas (USDA, NRCS 2002), and now documented in Florida. This species has been reported (sometimes as *Peplis diandra* Nutt. ex DC.) for Florida in many floras, (e.g., Chapman 1860; Correll & Johnston 1970; Crow & Hellquist 2000; Fassett 1957; Fernald 1950; Gleason & Cronquist 1963, 1991; Radford et al. 1968; Small 1933). The basis for these reports is not known. No Florida material was found at NY, the principal repository for A. W. Chapman and J. K. Small collections (Stafleu 1967). A search of the herbaria at FLAS and FSU also yielded no Florida material. It is not reported by Godfrey and Wooten (1981), Clewell (1985), or Wunderlin (1982, 1998). The species is apparently rare in much of its natural range, but is rather inconspicuous and perhaps has been overlooked. It is sometimes grown as an aquarium plant, but it is not believed that the Sarasota plants represent an introduction.

Rudbeckia auriculata (Perdue) Kral—Walton Co.: along US 331, 0.5 mi N of

FL 2 at Gordon, ca. 6.5 mi S of Paxton, roadside bog, 17 Aug 2000, *Searcy s.n.* (USF). A rare species, "eared coneflower" is known only from Georgia, Alabama (USDA, NRCS 2002), and now Florida. A second attempt to locate the plants was unsuccessful.

ACKNOWLEDGMENTS

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BOOKS RECEIVED/NOTICES

Annotations and comments by Editor

Taxonomic/Systematic

JAMES D. STUART and JOHN O. SAWYER. Illustrarted by ANDREA J. PICKART. 2002. **Trees and Shrubs of California.** (ISBN 0-520-22110-9, pbk.). University of California Press, Berkeley, CA 94720, U.S.A. (Orders: California Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, NJ 08618, U.S.A., 609-883-1759, 609-883-7413 fax, www.ucpress.edu). Price not given, 467 pp., 40 color photos, over 200 line drawings, 300 range maps, 4 3/4" × 7 1/4".

KEY WORDS: Trees, Shrubs, Identification, California, Pictorial Works.

GRAHAM NICHOLLS, RICK LUPP (Consulting Editor), and Foreword by BOBBY WARD. 2001. **Alpine Plants of North America. An Encyclopedia of Mountain Flowers from the Rockies to Alaska.** (ISBN 0-88192-548-9, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $49.95, hbk., 344 pp., 495 color photos, 2 maps, 7 3/8" × 10 3/8".

KEY WORDS: Alpine Plants, Mountain Plants, Wild Flowers, West (U.S., Canada), Pictorial Works.

DONALD E. SCHNELL. 2001. **Carnivorous Plants of the United States and Canada. Second Editon.** (ISBN 0-88192-540-3, hbk.). Timber Press, 133 SW Second Ave., Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $39.95, hbk., 468 pp., 200 color photos, 7 line drawings, 27 maps, 6" × 9".

KEY WORDS: Carnivorous Plants, United States, Identification, Venus Flytrap, Pitcher Plants, California Pitcher Plant, Sundews, Butterworts, Bladderworts.

ARMANDO T. HUNZIKER. 2001. **Genera Solanacearum: The Genera of Solanaceae Illustrated, Arranged According to a New System.** (ISBN 3-904144-77-4, hbk.). A.R.G. Gantner Verlag, Ruggell / Liechtenstein. (Orders: Koeltz Scientific Books, P.O. Box 1360, D 61453 Koenigstein / Germany; +49 6174 937240 fax; koeltz@t-online.de, http://www.koeltz.com). $120.00, 500 pp, 136 line drawings, 6 1/2" × 9 1/2".

KEY WORDS: Solanaceae, keys, descriptions, illustrations, 92 genera.

SHARON C. YARBOROUGH and A. MICHAEL POWELL. 2002. **Ferns and Fern Allies of the Trans-Pecos and Adjacent Areas.** (ISBN 0-09672-476-X, pbk.). Texas Tech University Press, Box 41037, Lubbock, TX 79410, U.S.A. (Orders: 800-832-4042, www.ttup.ttu.edu/). $17.95, 128 pp., 37 line drawings, range maps, 6" × 9".

KEY WORDS: Ferns, Pteriodophyta, Trans-Pecos, Texas, New Mexico, identification.

CRYPTOCORYNE BECKETTII COMPLEX (ARACEAE) INTRODUCED AT A FLORIDA SPRING

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ABSTRACT

A vegetative population of *Cryptocoryne* (Araceae), introduced at a Florida spring, appeared to represent three closely related species in the *C. beckettii* complex: *C. beckettii Thw.* ex Trimen, *C. wendtii* de Wit and *C. undulata* Wendt. Individuals of *C. undulata* were true to type and could be delineated at the site. Intergradation of diagnostic features was common in others, upon transplanting and flowering. While some transplants produced spathes characteristic of either *C. wendtii* or *C. beckettii*, intermediates between the two species were common. Neither *C. beckettii* nor *C. wendtii* could be delineated at the site. The seclusion of the stream and the integrity of native plant communities have likely prevented dispersal downstream.

RESUMEN

Una población vegetativa de *Cryptocoryne* (Araceae), introducida en un manantial de Florida, al parecer representa tres especies estrechamente relacionadas del complejo *C. beckettii*: *C. beckettii* Thw. *ex* Trimen, *C. wendtii* de Wit y *C. undulata* Wendt. En el lugar de estudio, fueron clasificados como verdaderos tipos ejemplares de *C. undulata*. En otros ejemplares, después del transplante y floración, fue común observar intergradación de caracteres diagnósticos. Aún cuando algunos transplantes produjeron espatas, características de *C. wendtii* o de *C. beckettii*, fue común observar ejemplares con características intermedias de ambas especies. Las especies *C. beckettii* y *C. wendtii* no fueron delineadas en el sitio de estudio. La condición de aislamiento del manantial y la condición íntegra de las comunidades de plantas nativas han impedido probablemente la dispersión corriente abajo.

INTRODUCTION

Cryptocoryne Fisher ex Wydler are highly sought-after and commercially marketed as decorative plants for tropical aquariums. The most commonly cultivated species belong to the *C. beckettii* complex, a uniform and specialized group endemic to Sri Lanka (Jacobsen 1977; Jacobsen 1987; de Graaf & Arends 1986).

In their native range, members of the *Cryptocoryne beckettii* complex inhabit pristine rivers and springs. In some areas, they form large submersed or emergent stands (Jacobsen 1987), although some populations have declined from commercial collecting and habitat destruction (de Graaf & Arends 1986). Species in this group commonly root in the sand and silt that overlay rocky, shallow streambeds (de Graaf & Arends 1986; Rataj & Horeman 1977) and occupy

shady, sheltered niches rarely inhabited by other plants (Jacobsen 1977; Doyle 2001). They adapt readily to terrestrial conditions and flower with water draw down, when leaves become emersed and the roots well aerated (Jacobsen 1977; Clark 1991). Vegetative reproduction is important in population establishment and expansion (Jacobsen 1977). In cultivation, *C. beckettii* members are hardy and vigorous, propagating abundantly by rhizomes and stolons, and enduring hard, calcium rich water (Miller 1998; Rataj & Horeman 1977).

In treating *Cryptocoryne* for the Flora of Ceylon, Jacobsen (1987) portrayed four species as closely related within the *Cryptocoryne beckettii* complex: *Cryptocoryne walkeri* Schott, *C. beckettii* Thw. ex Trimen, *C. wendtii* de Wit, and *C. undulata* Wendt. Although mainly diploids, all four have been found as triploid species and several combinations within the complex have resulted in the formation of hybrids (Jacobsen 1977; Arends et al. 1982; Jacobsen 1987). Because *Cryptocoryne* share many similarities in their vegetative features, an inflorescence is requisite for species identification. Determination of the species in the *C. beckettii* group rests on subtle differences in the morphology of the spathe, which is a fleshy, ornate bract enclosing the inflorescence. Key features of the spathe include the size and color of the collar and the shape and degree of twist of the terminal limb. Since differences in these characters are essentially quantitative, it has been recognized that the four taxa could prove to constitute a single species (Jacobsen 1987).

Wunderlin's (1998) inclusion of *Cryptocoryne wendtii* de Wit as an introduced component of the Florida flora was the first recording of this Southeast Asian genus for North America. Soon after, Rosen (2000) reported *C. beckettii* Thw. ex Trimen as introduced to Texas, followed by Doyle (2001) who detailed its expansion and spread in the upper spring-fed regions of the San Marcos River.

Rosen's description of *C. beckettii* from the San Marcos River, Texas, was based on vegetative material (Rosen 2000). Doyle (2001) reported that *C. beckettii* had been adequately confirmed in Texas after K. Sanders and D. Lemke identified flowering transplants. Wunderlin's report of *C. wendtii* in Florida was similarly based on a sterile specimen collected at Rainbow Springs Aquatic Preserve, Florida, in 1989. The objective of this inquiry was to confirm the persistence of *Cryptocoryne* at Rainbow Springs Aquatic Preserve and to collect material for cultivation and subsequent species determination from flowering plants.

The Rainbow River is a karstic, spring-fed stream receiving artesian groundwater that is high in clarity, rich in soluble carbonates and moderate in temperature (USGS 1999). The run traverses 8 km before joining the Withlacoochee River near the town of Dunnellon. A site of exceptional scenic beauty and a popular destination for recreation, it was designated the Rainbow Springs Aquatic Preserve in 1986 (Florida Statute 258.39 [32]).

METHODS

In May 2000 and in June 2001, approximately 50 individuals were uprooted from the *Cryptocoryne* colony found at Rainbow Springs Aquatic Preserve. Four sided, open-ended aluminum units (0.25 m^2) enclosed in double netting were placed over each area during sampling to delineate the sampling area and to trap stray plant fragments. Sampling attempted to localize variation observed in leaf color and in total represented seven areas within the colony. Samples were transplanted to 10 cm pots in a bark and peat-based potting medium and cultivated out of water, outdoors, with shade and screening, during the warmer months. Transplants established readily, losing submersed leaves and producing new terrestrial foliage. Pots were moved to a heated greenhouse when nighttime temperatures dropped below 10°C. Flowering began in December and continued through July. The inflorescences survived for several days and were documented with photographs and voucher specimens before decline. On pressing and drying, the inflorescences lost color and the angle of terminal limbs appeared more upright. Photography provided for better study than did prepared specimens. Species identification was based on Jacobsen (1987).

To assess plant density, the extent of subsurface rhizomes, and the potential of hand removal as a control method, total vegetation was harvested from two 0.25 m^2 areas within the colony. Limestone gravel was removed with fingers as necessary to extract plants in whole (i.e. with basal parts and some extent of rhizomes intact). Roots were harvested to approximately 10 cm deep. Top portions of plants were separated from subsurface material (roots). Weight was taken before and after material was oven dried at 60°C.

Adjacent, sterile colonies of *Myriophyllum* and Cyperaceae were sampled for subsequent transplanting, flowering and identification. *Myriophyllum* was tank cultivated in 50 cm of water, the sedge was grown under terrestrial conditions.

RESULTS AND DISCUSSION

Cryptocoryne was found persisting and well established at Rainbow Springs Aquatic Preserve, in a shaded cove of a spring fed stream. The plants grew submersed in an area of approximately 130 m^2. Water depth ranged from 28 to 75 cm, although outlying runners extended to crevices as deep as 150 cm. The low growing plants reached an average height of 7 cm. The vegetation consisted of dense mats that grew to the exclusion of other macrophytes.

Transplants from the *Cryptocoryne* colony produced approximately 100 inflorescences. Voucher specimens and photographs documented 49 representative inflorescences. Twenty-five appeared characteristic of three species in the *C. beckettii* complex: *C. undulata*, *C. beckettii*, and *C. wendtii* (Fig. 1–3). However, 20 were intermediate between *C. beckettii* and *C. wendtii*. *Cryptocoryne*



FIG. 1. *Cryptocoryne undulata* Wendt.

undulata was the only species that could be delineated at the Preserve. The remaining, and predominant, vegetation at the site could not be delineated as either *C. beckettii* or *C. wendtii*.



FIG. 2. *Cryptocoryne wendtii* de Wit.

Spathes of *C. undulata* were uniform in color and morphology. The collar zone graded from yellow to cream and the terminal limb darkened from yellow to golden brown upon maturing. The terminal limb was always nearly doubly twisted and positioned diagonally to the axis of the spathe tube. *Cryptocoryne undulata* was delineated within a small (approx. $4m^2$), distinct region of the colony. Submersed, unopened inflorescences found within this region were similarly yellow at the collar zone and on the inside of the unfurled limb.

Submersed leaf blades of *C. undulata* were narrowly lanceolate. They ranged in length from 4.0 to 9.0 cm (mean 6.1, SD 1.5) and in width from 0.7 to 1.8 cm (mean 1.3, SD 0.4). Bases were cordate to cuneate and the entire leaf margin was crisped. Submersed leaf color was dark brownish green on the adaxial surface; abaxial sides and petioles were maroon. Terrestrial plants of *C. undulata* produced smaller lanceolate leaves with acuminate bases and margins that were crisped only along the leaf base. Terrestrial leaf color was deep green with veins and petioles red.

While four transplants produced spathes characteristic of *C. wendtii*, and 17 characteristic of *C. beckettii*, more than 20 individuals appeared intermedi-

ate and could not be determined to the species level. Jacobsen (1987) separated *C. beckettii* from *C. wendtii* by the angle on the terminal limb of the spathe. The limb of *C. beckettii* is more upright or sub-erect, and twisted to recurved while that of *C. wendtii* is obliquely twisted, often extending into a tail (Jacobsen 1987). Jacobsen (1976) noted these characters as difficult to describe and variable, partly in response to environmental conditions. In the present study, the key characters were found to intergrade across a population grown under greenhouse conditions. The angle of the terminal limb (as measured from the spathe tube) ranged widely from 93°to 175°(Table 1). Limbs assumed different shapes, as well as angles, and spathes frequently shared diagnostic features. For example, spathes with sub-erect limbs (limbs not obliquely twisted) were found extending into well-defined tails (Fig. 4b).

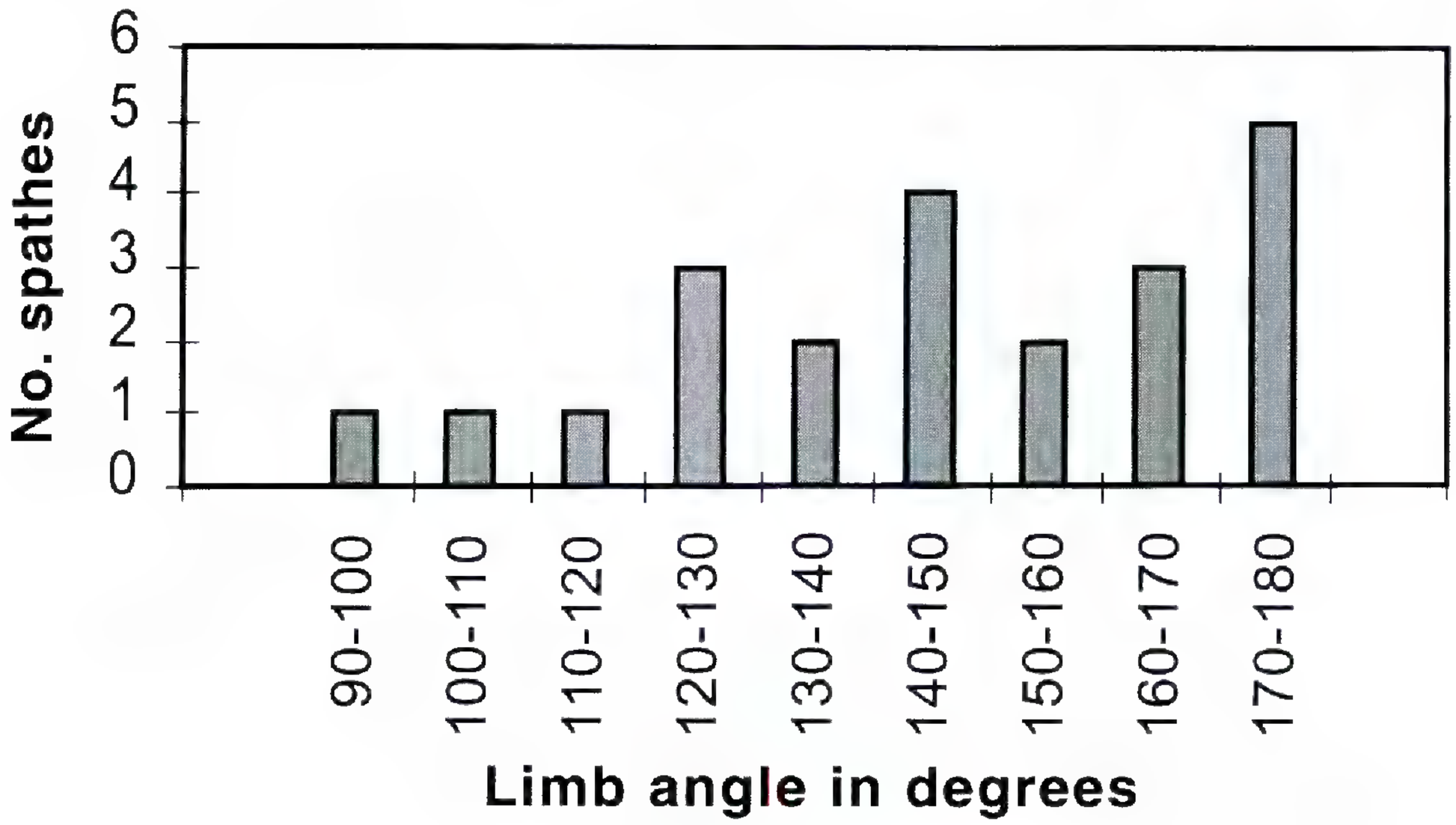
Jacobson (1976; 1987) further depicted the terminal limbs of *C. beckettii* as yellowish to brownish and those of *C. wendtii* as yellowish to purplish brown. In this study limbs varied in color from golden to green to greenish or purplish brown. On occasion they darkened with maturity. Limb color did not always correlate with limb position, for example, greenish brown limbs ranged from more erect to nearly perpendicular (Fig. 4d) and true green limbs were found twisted at an angle (Fig. 4a). Thus, in form and color many individuals in this study appeared intermediate between *C. beckettii* and *C. wendtii*.

The identity of those individuals that could be determined according to floral characteristics was often in question when apparently distinct individuals (*C. beckettii* and *C. wendtii*) were traced back to the same sampling block at the Preserve (Fig. 5 and representative specimens *Jacono 373* vs. *Jacono 368*). As a result, clear clonal populations, although expected for long established, vegetatively reproducing plants, could not be delineated for either *C. beckettii* or *C. wendtii*.

Submersed inflorescences found in sunny shallow areas had purple collar zones and green inner limbs. However, with spathes tightly furled, they contributed little in separating *C. beckettii* from *C. wendtii*, and merely confirmed the ability of this type to flower *in situ*.

Plants of this type (*C. beckettii*, *C. wendtii*, and the intermediates) demonstrated differences in leaf color while growing at the Preserve. Submersed leaf color of the adaxial surfaces varied from green marbled with brown to pink infused with green venation. Abaxial sides were violet to pink. This color variation was apparent in zones and may be attributed to factors of substrate and sunlight at the site. Green-brown plants grew in organic sediment under continuous shade of the tree canopy; pink plants grew on limestone substrate in zones of higher sunlight. After transplanting, the terrestrial leaves that replaced the submersed vegetation were without variation and uniform in color. The submersed leaves were lanceolate to ovate with cordate bases and sinuous margins. The length of their leaf blades ranged from 3.8 to 9.6 cm (mean 6.2, SD 1.5)

Table 1. Distribution of limb angles (measured from the spathe tube) of 22 inflorescences photographed.



and their width measured 1.1 to 3.3 cm (mean 2.2, SD 0.6). Terrestrial leaves were smaller and narrowly ovate with cordate bases, olive-green adaxial surfaces and violet on the abaxial side.

Variability and intergradation of the features upon which these species are based prevented delineation of *C. beckettii* from *C. wendtii*. While certain individuals seemed easy to place to the species level, they could not be traced back to distinct areas at the site. Other individuals were intermediate and could not be determined to species. Regardless of spathe morphology, terrestrially grown transplants within this type were consistently uniform in vegetative features. The predominating *Cryptocoryne* material at the Preserve can only be described as *C. beckettii* sensu lato.

The *Cryptocoryne* subsurface biomass consisted of large amounts of roots, rhizomes and stolons that were difficult to uproot by hand. Roots were well entrenched in contrasting substrates: silty, organic sediment near the shoreline and pebbled to rocky limestone extending into the stream.

Plant density values were 1480 plants / m^2 for *Cryptocoryne beckettii* s.l. and 1880 plants / m^2 for *C. undulata*. Dry roots of *C. beckettii* s.l. weighed nearly four times more than dry top growth: dry roots of *C. undulata* weighed eight times that of corresponding top growth (Table 2).

Like many aroids, *Cryptocoryne* employ contractile roots to adjust plant level after heaving or flooding (Bown 1988). Tiny rootlets sent deep into the rock use root pressure to contract in length and pull the roots farther into the



FIG. 3. *Cryptocoryne beckettii* Thw. ex Trimen.



FIG. 4. Intermediates of *Cryptocoryne beckettii and C. wendtii,* a–d (left to right).

TABLE 2. Plant density and top to root growth, per m^2 of submersed plants.

	No. of plants	Top fresh wt. in g	Top dry wt. in g	Roots fresh wt. in g	Roots dry wt. in g	Roots/ Top
Cryptocoryne undulata	1880	349g	23.2 g	1007g	183.8g	7.9
Cryptocoryne beckettii s.l.	1480	251g	20 g	426g	74g	3.7

substrate. This adaptation firmly anchors plants in swift currents and likely accounts for the deep rooting in limestone substrate at the Preserve, complicating mechanical removal without destructive draglines or dredging.

Shortened runners, basal shoots, were formed at the base of both submersed and transplanted material of all three species. Jacobsen (1987) described these "bulbil-like runners" on forms of *C. wendtii* and *C. undulata*, but did not report them for *C. beckettii*. Small (< 5mm), abundant (up to 8–20 per individual), and fragile, the shoots are loosely associated with the mother plant and readily break off. They quickly develop an initial root and primary leaf to establish as new plants. Kane et al. (1999) successfully employed basal shoots for the *in vitro* propagation of *C. wendtii*. At the Preserve, basal shoots were abundant in springtime. In transplants, they provided the flush of new season growth after spring flowering. Walking on submersed plants can dislodge basal shoots, which immediately sink to the bottom. Conversely, dislodged rhizomes float on the water surface. Because of their abundance and small size, the shoots are difficult to contain and may be carried downstream with bottom currents; they may be more effective than rhizome fragments as propagules for downstream spread.

Reproduction in *Cryptocoryne*, like other submersed macrophytes, is primarily accomplished through vegetative structures. Rhizomes, runners (stolons) and basal shoots provide multiple means for expansion of an apparently well-suited population at Rainbow Springs Aquatic Preserve.

Submersed inflorescences were observed in April and June on both types of *Cryptocoryne* at the Preserve. In their native range, *Cryptocoryne* commonly grow submersed during rainy periods and emerge to flower when seasonal water levels drop (Jacobsen 1977). Submersed inflorescences, while not uncommon in nature, must emerge to be insect pollinated before forming seeds. Typically short-lived, the seeds may be dispersed in water but are not vectored long distances over land (Bown 1988; Jacobsen 1976; Bogner 1987). Constant water level ensured by the spring flow should keep the inflorescences of submersed plants underwater. However, species in the *C. beckettii* complex are well adapted to terrestrial life (Jacobsen 1977) and runners could establish amphibious plants that might flower along the damp, shady shoreline at the Preserve.

Cryptocoryne was found encroaching on adjacent *Sagittaria kurziana* Glück, *Myriophyllum heterophyllum* Michx. and a continually inundated popu-

lation of *Rhynchospora colorata* (L.) H. Pfeiff. Several meters downstream, *Zizania aquatica* L., *Rorippa floridana* Al-Shehbaz & Rollins, *Ludwigia repens* J.R. Forst., *Sagittaria lancifolia* L., *Hydrocotyle umbellata* L., *Chara, Fontinalis, Utricularia, and Leersia* spp. contributed to one of the few intact aquatic communities remaining at the Preserve. The natural vegetation may curtail the downstream spread of *Cryptocoryne* by trapping dislodged rhizomes and shoots. Extensive underwater monitoring conducted in 1996 and 2000 detected no additional sites with *Cryptocoryne* at Rainbow Springs Aquatic Preserve (P. Sleszynski, pers. comm.).

Assessing Risks

In North America, weedy infestations of *Cryptocoryne beckettii* sensu lato may be limited to karstic spring environments of the southern states. Laboratory experiments demonstrated that four *Cryptocoryne* species, *C. affinis* Hook.f., *C. cordata* Griffith, *C. elliptica* Hook.f. and *C. minima* Ridley, effectively used bicarbonate as the main carbon source when pH ranged between 7.5 and 9.1 (Cheng and Mansor 2000). In high pH (>7.0), hard water systems, relatively large amounts of dissolved inorganic carbon exist as bicarbonate (Spencer and Bowes 1990). At Rainbow Springs Aquatic Preserve the spring water is consistently alkaline and carbonate-rich. Within the last decade pH ranged from 7.87 to 8.27 (USGS 1999). Total hardness value, last determined in 1980, was 58 mg/L, measured as calcium carbonate, and noncarbonate hardness was 3 mg/L, expressed as equivalents of calcium carbonate, indicating a high level of carbonate in the water (USGS 1999). Similar pH values (7.6 to 8.0) were recorded near the headspring of the San Marcos River, although hardness values were not determined (USGS 2000). The ability of *Cryptocoryne* to selectively use bicarbonate under alkaline conditions may contribute to its successful colonization at karstic spring-fed streams in Florida and Texas.

The original *Cryptocoryne* "mother plants" were probably planted at Rainbow Springs Aquatic Preserve before 1986 when the system came under state ownership. Now well established, its potential for dispersal there is considerable. In the San Marcos River, disturbance caused by wading and sporting activities are suspected to contribute to the proliferation of *Cryptocoryne beckettii* downstream (P. Power, U.S. Fish and Wildlife Service, San Marcos, Texas, pers. comm.). Owens et al. (2001) reported a significant increase in dislodged plant fragments below high recreation use areas on the San Marcos River. Likewise, recreational activities were reported as significant in the uprooting of large masses of vegetation in Rainbow River (Mumma et al. 1996). The secluded stream harboring *Cryptocoryne* at Rainbow Springs Aquatic Preserve is currently restricted, but under consideration for public use.

Original voucher specimen. ***Cryptocoryne wendtii*** de Wit, **U.S.A. FLORIDA, Marion Co.:** Dunnellon, Rainbow Springs Aquatic Preserve, quiet spring runs along the Rainbow River, lvs pink/green, frequent, 24 Apr 1989, *Joe Hinkle s.n.* (FLAS), Det: Walter Driggers.



FIG. 5. Apparently distinct individuals transplanted from the same sampling area at the Preserve.

Representative specimens from this study: **U.S.A. Florida. Marion Co.**, Dunnellon, Rainbow Springs Aquatic Preserve, spring run along the Rainbow River.

Cryptocoryne undulata Wendt—Submersed to 75cm at site, sterile: 11 Apr 2001, *Jacono 253* (FLAS, MO); 12 Jun 2001, *Jacono 280* (FLAS). Submersed to 75cm at site, fertile with spathes closed: 11 Apr 2001, *Jacono 254* (FLAS). Flowering in cultivation: 10 Apr 2001, *Jacono 282* (MO); 31 July 2001, *Jacono 296* (FLAS); Apr 2002, *Jacono s.n.* (FLAS); 7 Apr 2002, *Jacono 408* (FLAS).

Cryptocoryne beckettii Thw. ex Trimen—Flowering in cultivation: 17 Dec 2001, *Jacono 368* (MO); 18 Feb 2001, *Jacono 211* (FLAS); 7 Apr 2001, *Jacono 231* (FLAS); 7 Apr 2001, *Jacono 233* (MO); 16 Apr 2001, *Jacono 245* (FLAS).

Cryptocoryne wendtii de Wit—Flowering in cultivation: 14 Feb 2001, *Jacono 210* (FLAS); 29 Feb 2001, *Jacono 216* (FLAS); 27 Jan 2002, *Jacono 373* (MO).

Cryptocoryne beckettii sensu lato—Submersed to 28 cm at site, sterile: 11 Apr 2001, *Jacono 249*, (FLAS); 12 Jun 2001, *Jacono 275* (MO). Submersed to 28 cm at site, fertile with spathe closed, 11 Apr 2001, *Jacono 250* (MO); 12 June 2001, *Jacono 276* (FLAS). Flowering in cultivation with spathes apparently intermediate between *C. beckettii* and *C. wendtii*: 16 Apr 2001, *Jacono 243* (MO); 16 Apr 2001, *Jacono 244* (FLAS); 21 Feb 2001, *Jacono 247* (FLAS); 21 Feb 2001, *Jacono 271* (FLAS); 20 Feb 2002, *Jacono 379* (FLAS); 26 Mar 2002, *Jacono 402* (FLAS).

Myriophyllum heterophyllum Michx.—Submersed plants, rooted, sterile, 19 May 2000, *Jacono 140* (FLAS); Cultivated plants from sterile collection (*Jacono 140*) flowering and fruiting, 20 May 2001, *Jacono 270* (FLAS).

Rhynchospora colorata (L.) H. Pfeiff. Sterile plants submersed in ca. 70 cm of clear, flowing spring water, 12 Jun 2001, *Jacono 281* (FLAS); Cultivated plants from sterile collection (*Jacono 281*) flowering and fruiting, 8 Oct 2001, *Jacono 360* (NY; FLAS)].

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NEPHROLEPIS EXALTATA (DRYOPTERIDACEAE) NEW TO ARKANSAS

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ABSTRACT

Nephrolepis exaltata (Dryopteridaceae) is reported as new to Arkansas.

RESUMEN

Nephrolepis exaltata (Dryopteridaceae) se cita como nueva de Arkansas.

Nephrolepis Schott, the Sword Fern genus, consists of 25–30 species, mainly tropical in range, and is sometimes considered to be a small, monomorphic family (Kramer 1990). The genus name is from the Greek, meaning "kidney" and "scale," referring to the shape of the indusium. Species of this genus have given rise to many common cultivars that are excellent plants for growing on porches or other shaded locations outdoors in southeastern United States (Benedict 1916; Sessions 1978; Hoshizaki & Moran 2001). Four species and one hybrid are known to occur outside of cultivation in North America north of Mexico (Nauman 1993).

Native to southern one-half of peninsular Florida, *Nephrolepis exaltata* (L.) Schott has been extensively horticulturally selected and marketed as "Boston Fern". It is widely cultivated outdoors in the South. The specific epithet is from Latin, meaning "raised on high" or "lofty," referring to the perched site typically occupied in swamps. Its native range includes Florida, the West Indies and in scattered locations in the Pacific Islands, probably introduced, escaping, and becoming naturalized in many places. All populations in North America beyond Florida originated as escapes from cultivation from spores or abandoned plants. The species has escaped from cultivation and naturalized in peninsular Florida (Nauman 1981; Nauman et al. 2000), Orleans Parish, Louisiana (Thieret 1980), and Highland Park, Texas (pers. comm., G. Gibbs). In Arkansas it is a common horticultural or cultivated summer plant in every county in the state, with some winter-hardiness evident in the southernmost tier of counties.

Nephrolepis exaltata was first found in the wild in Arkansas on 25 September 2001 in natural woods east of Pine Bluff near the Arkansas River in Jefferson Co. One plant well mired in a mucky soil was found with 20 sterile fronds, obviously more than one year in age. The plant may have originated as the result

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of escaped spores or more likely from plants abandoned in some manner. The park area accumulates flotsam and jetsam from the Arkansas River at high water levels. Stranded debris, plastic cemetery decorations, and other fluvially deposited materials attest to the efficacy of this mechanism. The plant will be monitored for persistence, production of spores, and reproduction of new plants.

This is the sixth non-native fern of the Arkansas pteridophyte flora of 97. The other exotics are *Lygodium japonicum*, *Macrothelypteris torressiana*, *Ophioglossum petiolatum*, *Psilotum nudum* (in part), *Pteris multifida*, and *Salvinia minima*. Only the *Lygodium* shows any ecological activity to be considered as an invasive species. Until this single plant *Nephrolepis exaltata* demonstrates reproductive competence, it will best be regarded as a waif. Additional populations are expected from time to time in the southern part of state following a few years with mild winters. (It seems unlikely that they would survive an extremely hard winter.)

This first report for this genus and species in Arkansas is surprising late in coming in that this and other horticultural-cultivated sword ferns are grown extensively across the state. Apparently, they have not escaped or become routinely established mainly because of the prolonged heat and drought of late summer in Arkansas.

The Arkansas vernacular name is "Yankee Fern," reputed to be a gentle retaliation for the renaming of *Dryopteris Xaustralis* or Southern Log Fern by some Connecticut Yankees who placed that hybrid into the horticultural trade through tissue culture under the market name of Dixie Fern.

Voucher Specimen: **ARKANSAS: Jefferson Co.:** Wet riparian woods SE of Trulock Campground, off access road to Atkins Lake-Nobel Lake along Arkansas River, 10 mi E of Pine Bluff, T6S R7W S5, *Peck 2001388* (LRU).

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Annotations and comments by Editor

Taxonomic/Systematic

WALTER S. JUDD, ST. LOUIS, PETER F. STEVENS, and MICHAEL J. DONOGHUE. 2002. **Plant Systematics: A Phylogenetic Approach, Second Edition.** (ISBN 0-87893-403-0, hbk.). Sinaurer Associates, Inc., 23 Plumtree Road, Sunderland, MA 01375-0407, U.S.A. (Orders: 413-549-1118 fax; orders@sinauer.com, publisher@sinauer.com). $86.95, 576 pp, numerous line drawings, 8 1/2" × 11".

From Sinauer website (*www.sinauer.com*): "*Plant Systematics: A Phylogenetic Approach*, Second Edition is an introductory text that incorporates phylogenetic principles and methods throughout—from the careful explanation of phylogenetic methods and principles in the initial two chapters to the taxonomic survey of vascular plant families in the last two chapters."

"The text is accompanied by a much expanded CD ROM, containing over 2,200 color photos illustrating the diagnostic characters of (and variability within) the vascular plant families covered in the text, including many images showing floral and fruit dissections."

JOHN M. GILLETT and NORMAN L. TAYLOR. MICHAEL COLLINS (Editor). 2001. **World of Clovers.** (ISBN 0-8138-2986-0, hbk.; 0-8138-0282,-2, CD-ROM). Iowa State Press, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax; www.iowastatepress.com). $144.95 (hbk & CD-ROM), $99.95 (CD-ROM only), 488 pp, numerous b/w photos, 6" × 9".

From the back cover: "Descriptions are presented alphabetically by species name and enhanced by beautiful color photographs of the plants and their seeds on the fully searchable CD-ROM (black-and-white photos in the book)." The book and CD-ROM include the following information for each of the 228 recognized species: Botanical name, Common name, Detailed description of stipules, leaflets, heads, flowers, and pods, Lifespan, Flowering period, Habitat, and Distribution. Clovers are in the genus *Trifolium* and belong to the Fabaceae (bean family).

Plant Physiology/Pathology/Agriculture

LINCOLN TAIZ and EDUARDO ZEIGER, with contributors. 2002. **Plant Physiology, Third Edition.** (ISBN 0-87893-823-0, hbk). Sinaurer Associates, Inc., 23 Plumtree Road, Sunderland, MA 01375-0407, U.S.A. (Orders: 413-549-1118 fax; orders@sinauer.com, publisher@sinauer.com). $104.95, 690 pp, illustrated, 8 1/2" × 11".

From Sinauer website (*www.sinauer.com*): "... the new edition incorporates all the important new developments in plant physiology, especially in cell, molecular, and developmental biology."

CYNOSURUS ECHINATUS (POACEAE) NEW TO TEXAS

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Cynosurus echinatus L.—**TEXAS. Walker Co.:** Ebenezer Cemetery beside Hwy 30, 1 mi E of Farm Rd 2550, W of Huntsville, 30 May 1992, *R.D. Thomas 129,383* (BRIT, NLU).

The species has been reported from Oklahoma, Louisiana, Missouri, Arkansas, and many states of the eastern United States (Kartesz 1999). It also occurs in the Pacific coast states of California, Oregon, and Washington, and in British Columbia. Its closest known locality to the Walker County, Texas, site is in Caddo Parish, Louisiana (Thomas & Allen 1993). No plants of this species were relocated in a search of the Walker County site in June 1997 (pers. comm., Guy Nesom).

Cynosurus echinatus is native to southern Europe (Tutin 1980) and Africa, and Asia (Yatskievych 1999), but it is now established in North America, South America, and Australia. It is annual in duration and a colonizer of open disturbed sites, including fields, roadsides, and railways. Among various common names are "Hedgehog Dogtail," "Rough Dog's Tail," and "Bristly Dog's Tail Grass." A photograph is posted on the internet at <http://plants.montara.com / ListPages/FamPages/ Poa3.html#cynech>. Detailed line drawings are found at <http://biodiversity.uno.edu/ delta/grass/www/cynosuru.htm>.

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Plant Physiology/Pathology/Agriculture

ZDENKO RENGEL (Editor). 2002. **Handbook of Plant Growth pH as the Master Variable.** (ISBN 0-8247-0761-3, hbk.). Marcel Dekker, Inc., 270 Madison Avenue, New York, NY 10016, U.S.A. (Orders: 212-696-9000, 212-685-4540 fax, www.dekker.com). Marcel Dekker AG, Hutgasse 4, Postfach 812, CH-4001 Basel, Switzerland (Orders: 41-61-261-8482, 41-61-261-8896 fax) $175.00, 446 pp, 6" × 9".

From Marcel Dekker website (*www.dekker.com*): "This reference explores the molecular, biochemical, functional, structural, and developmental mechanisms of pH in plant growth, as well as examining the role of pH in plant symplasm, plant apoplasm, the rhizosphere, the ecosystem, and in plant interaction with biotic and abiotic environments."

ALLEN R. OVERMAN and RICHARD V. SCHOLTZ III. 2002. **Mathematical Models of Crop Growth and Yield.** (ISBN 0-8247-0825-3, hbk.). Marcel Dekker, Inc., 270 Madison Avenue, New York, NY 10016, U.S.A. (Orders: 212-696-9000, 212-685-4540 fax, www.dekker.com). Marcel Dekker AG, Hutgasse 4, Postfach 812, CH-4001 Basel, Switzerland (Orders: 41-61-261-8482, 41-61-261-8896 fax) $159.00, 328 pp, illustrated, 6" × 9".

From Marcel Dekker website (*www.dekker.com*): "This insightful **reference/text** describes the application of viable mathematical models in data analysis to increase crop growth and yields—highlighting effective, analytical functions that have been found useful for the comparison of alternative management techniques to *maximize water and nutrient resources*"

SAMUEL S. GNANAMANICKAM (Editor). 2002. **Biological Control of Crop Diseases.** (ISBN 0-8247-0693-5, hbk.). Marcel Dekker, Inc., 270 Madison Avenue, New York, NY 10016, U.S.A. (Orders: 212-696-9000, 212-685-4540 fax, www.dekker.com). Marcel Dekker AG, Hutgasse 4, Postfach 812, CH-4001 Basel, Switzerland (Orders: 41-61-261-8482, 41-61-261-8896 fax) $175.00, 468 pp, illustrated, 6" × 9".

From Marcel Dekker website (*www.dekker.com*): "This *innovative* reference combines theory with *current* global practices involved in the biological control of diseases in 12 major crops—highlighting the day-to-day challenges of organic crop management for cost-effective real-world application."

ADDITIONS TO THE FLORA OF NAGS HEAD WOODS (DARE COUNTY, NORTH CAROLINA) AND THE OUTER BANKS OF NORTH CAROLINA

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ABSTRACT

Including an extensive system of dunes, interdunal ponds, and wetlands, the Nags Head Woods Ecological Preserve (Dare Co., North Carolina) comprises one of the best remaining examples of mid-Atlantic maritime deciduous forests. This study presents additions to the flora of the preserve and the larger Outer Banks, based on recent collections. Thirty-four taxa have not previously been reported for the preserve, five have not been reported for the Outer Banks, and two have been rediscovered.

RESUMEN

La Nags Head Woods Ecological Preserve (Dare Co., North Carolina), que incluye un sistema extensivo de dunas, lagunas interdunares, y humedales, comprende uno de los mejores ejemplos restantes de bosques caducifolios marítimos atlánticos. Este estudio presenta adiciones a la flora de la reserva y los mayores Outer Banks, basado en colecciones recientes. Treinta y cuatro taxa no habían sido citados previamente de la reserva, cinco no habían sido citados de los Outer Banks, y dos han sido redescubiertos.

The Nags Head Woods Ecological Preserve (Kill Devil Hills, Dare Co.) comprises one of the best remaining examples of mid-Atlantic maritime deciduous forest (Schafale & Weakley 1990) and includes an extensive system of dunes, interdunal ponds, and wetlands. Recent progress toward a flora of the preserve provided a checklist of vouchered collections housed at the herbarium of the National Park Service Cape Hatteras National Seashore Unit (CAHA), Manteo, North Carolina (Krings 2002). Although not listed in either the *Index Herbariorum* (Holmgren et al. 1990) or Aulbach-Smith et al. (1986), CAHA constitutes a valuable resource of North Carolina barrier island collections. The collections from the Nags Head Woods Ecological Preserve (NHWEP) housed at CAHA include material collected by various members of the Dunes of Dare Garden Club, McCaffrey, as well as Stalter and Lamont (1997). This study presents new additions to the flora of the preserve and the larger Outer Banks (sensu Stalter & Lamont 1997), resulting from recent collections by the author and preserve staff.

METHODS

The list was compiled based on field collections by the author and preserve

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staff over the period of Mar 2001–Sept 2002. Specimens were critically studied and identified at the herbarium of North Carolina State University (NCSC).

RESULTS

Species at the NHWEP listed below include new additions to the flora, as well as species previously reported but not vouchered by Blonder and Stalter (1992) or Stalter and Lamont (1997). Asterisks preceding a scientific name indicate that taxon to be a new addition to the flora of NHWEP (i.e., not previously reported by Blonder and Stalter (1992) or not specifically reported for the preserve by Stalter and Lamont (1997)).

The list includes 89 species, 34 (38%) of which have not been previously reported for the preserve, and 5 (~6%) of which have not been reported for the Outer Banks (i.e., not listed in either Burk (1961), Blonder and Stalter (1992), or Stalter and Lamont (1997)).

Pteridophyta

ASPLENIACEAE

**Asplenium platyneuron* (L.) BSP., *Krings 450* (NCSC)

OSMUNDACEAE

Osmunda cinnamomea L., *Krings 534* (NCSC)

Osmunda regalis L. var. *spectabilis* (Willd.) A. Gray, *Krings 538* (NCSC)

Gymnospermae

CUPRESSACEAE

Juniperus virginiana L., *Krings 373* (NCSC)

PINACEAE

Pinus palustris Mill., *Krings 563* (NCSC)

Pinus taeda L., *Krings 564* (NCSC)

TAXODIACEAE

Taxodium distichum (L.) Rich., *McCall s.n.* (NCSC)

Angiospermae
Monocotyledonae

CYPERACEAE

**Carex albolutescens* Schwein., *Krings 554* (NCSC); *Krings 555* (NCSC)

Schoenoplectus americanus (Pers.) Volk ex Schinz. & R. Keller, *Krings 546* (NCSC)

JUNCACEAE

Juncus canadensis J. Gay, *Krings 556* (NCSC); Krings 560 (NCSC)

Juncus roemerianus Scheele, *Krings 540* (NCSC)

LILIACEAE

**Hemerocallis fulva* (L.) L., *Krings 451* (NCSC)

ORCHIDACEAE

Cypripedium acaule Aiton, *Krings 471* (NCSC)

POACEAE

Arundinaria tecta Walt., *Krings 541* (NCSC)

**Erianthus giganteus* (Walt.) Muhl., *Krings 559* (NCSC)

Glyceria septentrionalis Hitchc., *Krings 561* (NCSC)

Panicum amarum Elliott, *Krings 558* (NCSC)

**Panicum scoparium* Lam., *Krings 557* (NCSC)

Phragmites australis (Cav.) Trin. ex Steud., *Krings 520* (NCSC)

**Setaria geniculata* P. Beauv., *Krings 521* (NCSC)

**Setaria magna* Griseb., *Krings 544* (NCSC)

SMILACACEAE

Smilax glauca Walter, *Krings 465* (NCSC); Krings 487 (NCSC)

**Smilax smallii* Morong, *Krings 525* (NCSC)

TYPHACEAE

Typha angustifolia L., *Krings 549* (NCSC)

Dicotyledonae

ACERACEAE

Acer rubrum L., *Krings 377* (NCSC)

ANACARDIACEAE

Rhus copallina L., *Krings 514* (NCSC)

APIACEAE

Centella erecta (L.f.) Fern., *Krings 562* (NCSC)

**Ptilimnium capillaceum* (Michx.) Raf. ex Ser., *Krings 533* (NCSC)

AQUIFOLIACEAE

Ilex vomitoria Aiton, *Krings 386* (NCSC)

ARALIACEAE

Aralia spinosa L., *Krings 463* (NCSC)

ARISTOLOCHIACEAE

**Aristolochia serpentaria* L., *Krings 517* (NCSC)

ASTERACEAE

**Achillea millefolium* L., *Krings 543* (NCSC)
Carduus spinosissimus Walter, *Krings 466* (NCSC)
**Chrysanthemum leucanthemum* L., *Krings 452* (NCSC)
Eupatorium hyssopifolium L., *Krings 522* (NCSC)
**Gaillardia pulchella* Foug., *Krings 456* (NCSC)
Iva frutescens L., *Krings 551* (NCSC)

BETULACEAE

Ostrya virginiana (P. Mill.) K. Koch., *Krings 374* (NCSC)

BRASSICACEAE

**Cardamine hirsuta* L., *Krings 389* (NCSC)
Lepidium virginicum L., *Krings 530* (NCSC)

BIGNONIACEAE

Campsis radicans (L.) Seem., *Krings 523* (NCSC)

CAPRIFOLIACEAE

Lonicera japonica Thunb. ex Murray, *Krings 472* (NCSC)
Lonicera sempervirens L., *Krings 535* (NCSC)

CELASTRACEAE

**Celastrus orbiculatus* Thunb., *Krings 532* (NCSC)

CISTACEAE

**Helianthemum canadense* (L.) Michx., *Krings 550* (NCSC)

CONVOLVULACEAE

Calystegia sepium (L.) R.Br., *Krings 527* (NCSC)

CORNACEAE

**Cornus stricta* Lam., *Krings 536* (NCSC)
Cornus florida L., *Krings 486* (NCSC)

EUPHORBIACEAE

Cnidoscolus stimulosus (Michx.) Engelm. & A. Gray, *Krings 462* (NCSC)
**Tragia urens* L., *Krings 515* (NCSC)

FABACEAE

**Desmodium nuttallii* (Schindler) Schubert, *Krings 512* (NCSC)
**Pueraria lobata* (Willd.) Ohwi var. *montana* (Lour.) Maesen, *Krings 531* (NCSC)
**Rhynchosia difformis* (Elliott) DC., *Krings 509* (NCSC)
**Trifolium arvense* L., *Krings 458* (NCSC)
**Wisteria sinensis* (Sims) Sweet, R. *Paris s.n.* (NCSC)

FAGACEAE

Quercus falcata Michx., *Krings 537* (NCSC)
**Quercus hemisphaerica* W. Bartr. ex Willd., *Krings 518* (NCSC)
Quercus stellata Wangenh., *Krings 516* (NCSC)

GERANIACEAE

**Geranium carolinianum* L., *Krings 477* (NCSC)

HAMAMELIDACEAE

Liquidambar styraciflua L., *Krings 464* (NCSC)

LAMIACEAE

Teucrium canadense L., *Krings 526* (NCSC)

LAURACEAE

Sassafras albidum (Nutt.) Nees, *Krings 380* (NCSC)

LOGANIACEAE

Gelsemium sempervirens St. Hilaire, *Krings 369* (NCSC)

MAGNOLIACEAE

Magnolia grandiflora L., *Krings 485* (NCSC)

MORACEAE

Morus rubra L., *Krings 475* (NCSC)

MYRICACEAE

Myrica cerifera L., *Krings 387* (NCSC)

ONAGRACEAE

**Oenothera laciniata* Hill, *Krings 455* (NCSC); *Krings 479* (NCSC)

OXALIDACEAE

Oxalis dillenii Jacq., *Krings 478* (NCSC)

PASSIFLORACEAE

**Passiflora lutea* L., *Krings 529* (NCSC)

PLANTAGINACEAE

**Plantago hookeriana* Fisch. & C.A. Mey. var. *nuda* (A. Gray) Poe, *Krings 454* (NCSC)
**Plantago psyllium* L., *Krings 457* (NCSC)

POLYGONACEAE

Polygonum hydropiperoides Michx., *Krings 552* (NCSC); *Krings 553* (NCSC)

PYROLACEAE

Chimaphila maculata (L.) Pursh, *Krings 372* (NCSC)

ROSACEAE

Amelanchier canadensis (L.) Medic., *Krings 375* (NCSC); *Krings 381* (NCSC)

Rosa palustris Marshall , *Krings 406* (NCSC)

Rubus trivialis Michx., *Krings 476* (NCSC); *R. Paris s.n.* (NCSC); *Krings 542* (NCSC)

RUBIACEAE

Cephalanthus occidentalis L., *Krings 410* (NCSC)

Galium hispidulum Michx., *Krings 370* (NCSC)

**Galium obtusum* Bigelow, *Krings 519* (NCSC)

Mitchella repens L., *Krings 484* (NCSC)

SALICACEAE

Salix caroliniana Michx., *Krings 539* (NCSC)

SAURURACEAE

Saururus cernuus L., *Krings 405* (NCSC)

SCROPHULARIACEAE

**Bacopa monnieri* (L.) Pennell, *Krings 528* (NCSC)

**Linaria canadensis* (L.) Dum. Cours., *McCall s.n.* (NCSC)

SOLANACEAE

**Physalis walteri* Nutt., *Krings 524* (NCSC)

VERBENACEAE

Callicarpa americana L., *Krings 411* (NCSC)

VIOLACEAE

**Viola sororia* Willd., *Paris s.n.* (NCSC)

VITACEAE

Ampelopsis arborea (L.) Koehne, *Krings 407* (NCSC)

Parthenocissus quinquefolia (L.) Planch., *Krings 468* (NCSC)

DISCUSSION

Table 1 lists species apparently discovered for the first time from the Outer Banks or rediscovered after not having been seen by Stalter and Lamont (1997). The find of *Aristolochia serpentaria* (Aristolochiaceae) is rather interesting, although not altogether surprising as it is generally associated with mixed deciduous forests (Radford et al. 1968). As few examples of maritime deciduous forests remain in North Carolina, the species likely remains rare due to habitat availability on the Outer Banks. Although relatively common in the North Carolina Coastal Plain, *Tragia urens* has been previously reported for the Outer Banks only by Burk (1961). Stalter and Lamont (1997) did not mention the taxon and presumably did not observe it. It remains unknown whether the taxon persists on Bogue Banks as reported by Burk (1961). *Celastrus orbiculatus* and *Pueraria lobata* var. *montana* have been weeds of concern to the preserve staff and efforts are underway to severely control, if not eradicate, them from the site.

ACKNOWLEDGMENTS

I thank the Nature Conservancy for access to the preserve and Aaron McCall, Rhana Paris, and Jeff DeBlieu for thoughtful conversations and collection help.

REFERENCES

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Blonder, B. and R. Stalter. 1992. Vascular plant species list: Nags Head Woods Preserve. The Nature Conservancy, Kill Devil Hills, NC.

TABLE 1. Newly discovered or rediscovered taxa for the Outer Banks.

Taxa	Burk (1961)	Stalter & Lamont (1997)	Present study
Aristolochiaceae			
Aristolochia serpentaria	Not listed	Not listed	Vouchered from NHWEP
Celastraceae			
Celastrus orbiculatus	Not listed	Not listed	Vouchered from NHWEP
Euphorbiaceae			
Tragia urens	Reported from Bogue Banks	Not listed	Vouchered from NHWEP
Fabaceae			
Desmodium nuttallii	Not listed	Not listed	Vouchered from NHWEP
Pueraria lobata var. *montana*	Reported from Nagshead	Listed as not recently observed	Vouchered from NHWEP
Plantaginaceae			
Plantago hookeriana var. *nuda*	Not listed	Not listed	Vouchered from NHWEP
Smilacaceae			
Smilax smallii	Not listed	Not listed	Vouchered from NHWEP

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BOOKS RECEIVED/NOTICES

Annotations and comments by Editor

Plant Physiology/Pathology/Agriculture

CHRISTOPHER P. DUNN (Editor). 2000. **The Elms Breeding, Conservation, and Disease Management.** (ISBN 0-7923-7724-9, hbk.). Kluwer Academic Publishers, Customer Service Department, P.O. Box 358, Accord Station, Hingham, MA 02018-0358, U.S.A. (Orders: 781-871-6600, Toll Free 866-269-9527, fax 781-681-9045, kluwer@wkap.com). $125.00, 361 pp, illustrated, 6" × 9".

From Kluwer website (*www.wkap.nl*): "Elms occur, both naturally and cultivated, throughout much of the temperate world. Because of their high tolerance to extreme growing conditions and their widespread distribution, elms have been widely planted in cities, towns and rural areas throughout North America and northern Europe. As such, their current demise due to several pandemics of Dutch elm disease has spurred a huge body of research on breeding for disease resistance, conservation and systematics. *The Elms: Breeding, Conservation and Disease Management* provides the current state of knowledge in these areas and is an important reference work for pathologists, breeders, taxonomists, and arborists."

GERALD C. NELSON (Editor). 2001. **Genetically Modified Organisms in Agriculture, Economics and Politics. (ISBN** 0-12-515422-4, hbk.). Academic Press, 200 Wheeler Road, Burlington, MA 01803, U.S.A. (Orders: 888-677-7357, 781-221-2212, Fax 781-221-1615, http://www.academicpress.com/www/ap/reps.htm). £46.95, 300 pp, illustrated, 6 1/2" × 9 1/2".

From Academic website(*www.apcatalog.com*): "In **Part 1**, *Genetically Modified Organisms* offers a comprehensive look at the science, economics, and politics of the use of agricultural GMOs. It provides in-depth coverage of the three most-widely used GMOs: *Bt* corn and cotton and glyphosate-resistant soybeans. Issues such as US and EU regulatory concerns, import/export patterns and the impact on international trade are covered. **Part 2** presents articles from leading figures with widely different views in the debate, such as representatives from the American Corn Growers Association, the EU Commission, The Foundation for Science, Technology and Natural Resource Policy, India, Center for Global Food Issues, Consumers' Union and the Biotechnology Industry Organization. Finally, **Part 3** provides more detailed information on selected topics, including the history of biotechnology innovations, the techniques of biotechnology, the latest research on the consequences of the Bt corn for the monarch butterfly, and a list of European GMO field trial approvals."

CIRSIUM NUTTALLII (ASTERACEAE: CYNAREAE) NEW TO NORTH CAROLINA AND AN ILLUSTRATED KEY TO SOUTHEASTERN CONGENERS

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ABSTRACT

Cirsium nuttallii (Asteraceae) is documented for North Carolina. The species had previously been known from Florida to South Carolina and from disjunct populations in Virginia. An illustrated key is provided to aid others in the diagnosis of *Cirsium* in North Carolina and the southeast.

RESUMEN

Se documenta *Cirsium nuttallii* (Asteraceae) para el estado de Carolina del Norte. Previamente se conocía la especie sólo desde Florida a Carolina del Sur y de poblaciones disyuntas en Virginia. Se presenta una clave ilustrada para ayudar los demás en las diagnosis de *Cirsium* en el sudeste.

A southeastern United States endemic, *Cirsium nuttallii* DC. (Asteraceae: Cynareae) has been previously known only from peninsular Florida to Louisiana and South Carolina, and from apparently disjunct populations in southeastern Virginia (Radford et al. 1968, Cronquist 1980). However, recently Randy Westbrooks found an individual in a pasture in Whiteville, Columbus Co., North Carolina. When surveyed, the plant was about 2.4 m tall. Apparently, it had not been seen in the pasture previously. Additional survey by Robert Eplee located a population lightly scattered over 10 acres, north of Hallsboro (also Columbus Co.). The species is known from at least 16 counties in South Carolina, including nearby Marion Co. North Carolina now includes all 12 species of native and naturalized *Cirsium* known from the southeast. Voucher specimens of *C. nuttallii* were prepared for deposit at NCSC, OBI, and US.

Voucher specimen: U.S.A. **NORTH CAROLINA. Columbus Co.:** Whiteville, in a pasture, roughly 8 ft tall, 24 Jun 2002, *R. Westbrooks s.n.* (NCSC, OBI, US).

Cirsium nuttallii DC. (Fig. 1H) is one of the tallest *Cirsium* species in the southeast, capable of attaining heights of 3.5 m (Cronquist 1980). Only *Cirsium altissimum* (L.) Sprengel and *C. discolor* (Muhl.) Sprengel are known to grow to

a similar maximum size (Cronquist 1980). These latter two can be distinguished from *C. nuttallii* by the abaxial leaf surface densely and persistently white tomentose (arachnoid-tomentose to glabrate in age in *C. nuttallii*).

Cirsium nuttallii can be distinguished from its southeastern congeners by the combination of the following traits: (1) plant biennial, 1.5–3.5 m tall, (2) stems not winged, but branched and many-headed, (3) abaxial leaf surface arachnoid-tomentose to glabrate in age, (4) involucres 1.5–2.5 cm long, and (5) middle and outer involucral bracts with a glutinous adaxial ridge and tipped by spines 1–2(–3) mm long. We are providing a key, largely adapted from Cronquist (1980), as well as illustrations in hopes they might prove of diagnostic use to others.

KEY TO *CIRSIUM* IN THE SOUTHEASTERN UNITED STATES

1. Stems conspicuously winged by spiny, decurrent leaf bases (Fig. 1A, i), the wings nearly or as long as the internodes _____ **Cirsium vulgare** (Savi) Ten. (Fig. 1A, ii)
1. Stems not winged by decurrent leaf bases.
   2. Heads conspicuously and closely subtended by a series of narrow, reduced, strongly spiny leaves (Fig. 1C) _____ **Cirsium horridulum** Michx.
   2. Heads not closely subtended by a series of reduced spiny leaves.
      3. Plant colonial, perennial (by creeping roots); polygamo dioecious, the heads nearly unisexual with the pappus of the pistillate head longer than the corresponding corollas and the pappus of the staminate heads shorter than the corresponding corollas (Fig. 1D, i & ii) _____ **Cirsium arvense** (L.) Scop.
      3. Plant not colonial, biennial or perennial; heads all similar and perfect.
         4. Involucral bracts completely lacking spiny tips or only exhibiting a vestigial spinule to 0.5 mm long (Fig. 1B) _____ **Cirsium muticum** Michx.
         4. Involucral bracts bearing spiny tips, the spines typically at least 1 mm long.
            5. Abaxial leaf surface densely and persistently white-tomentose.
               6. Plants robust, 1–3(–4) m tall; largest lobed leaves generally > 5 cm wide; involucres generally 2.5–3.5 cm long
                  7. Leaves deeply pinnatifid (Fig. 1F, i) _____ **Cirsium discolor** (Muhl. ex Willd.) Sprengel (Fig. 1F, ii)
                  7. Leaves toothed or shallowly lobed _____ **Cirsium altissimum** (L.) Sprengel (Fig. 1K)
               6. Plants relatively slender, 0.5–1.5 m tall; largest lobed leaves generally < 5 cm wide; involucres generally 1.5–2.5 cm long
                  8. Cauline leaves mostly 30–70; plants flowering in Aug–Oct; savannahs, bogs, and wet pinelands _____ **Cirsium virginianum** (L.) Michx. (Fig. 1E)
                  8. Cauline leaves mostly 10–25; plants flowering Apr–Jun; open woods and dry, sandy soil _____ **Cirsium carolinianum** (Walt.) Fern. & Schub. (Fig. 1G)
            5. Abaxial leaf surface arachnoid-villous (sometime sparsely so) to glabrate (particularly in age).
               9. Plants 1.5–3.5 m tall, branched and many-headed; involucres 1.5–2.5 cm long (Fig. 1H) _____ **Cirsium nuttallii** DC.
               9. Plants 0.2–1 m tall, unbranched or only sparingly branched; involucres 2.5–5 cm long.
                  10. Young stems and abaxial leaf surfaces thinly and loosely white

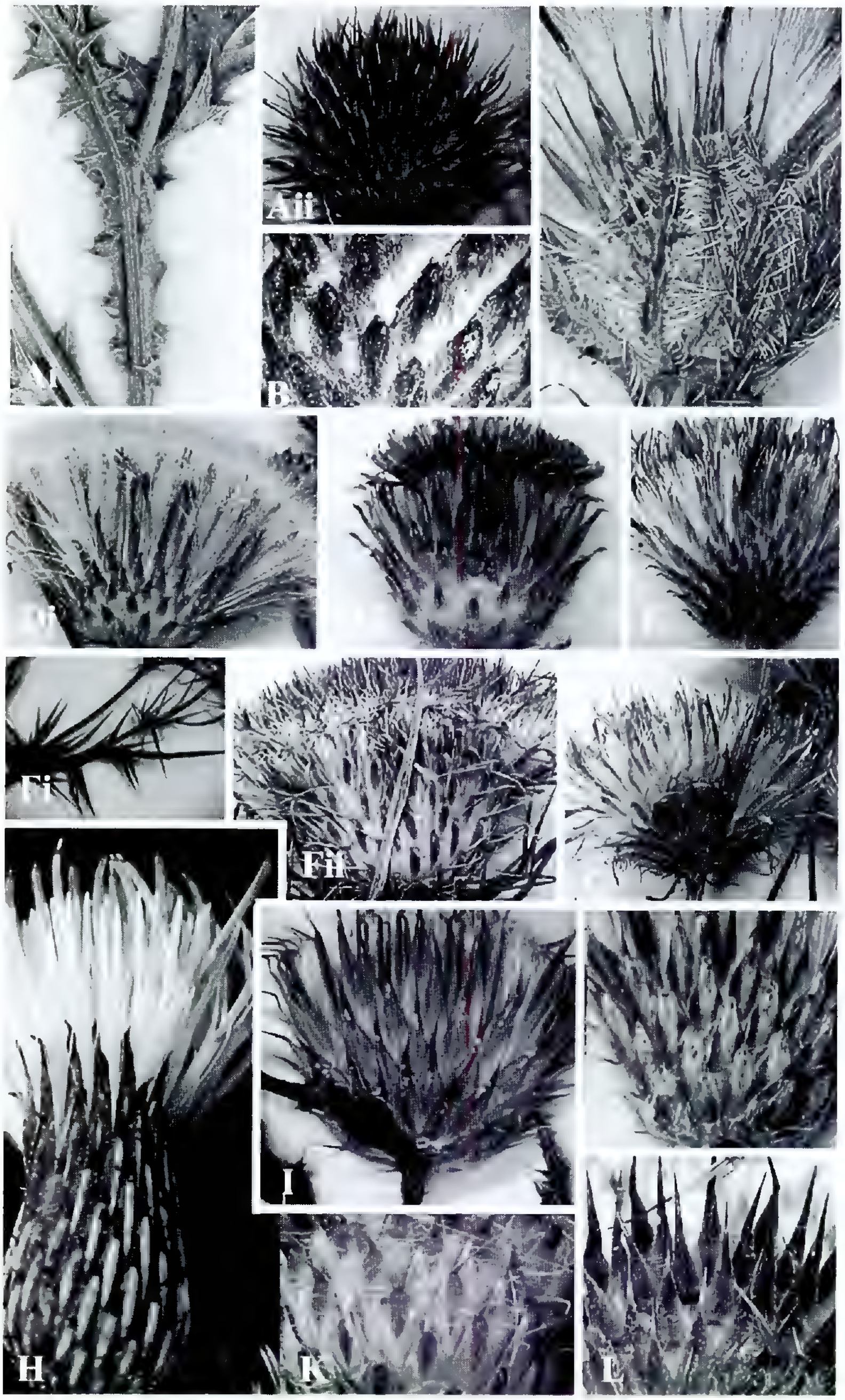


FIG. 1. Southeastern *Cirsium* (Asteraceae): **A,** *Cirsium vulgare* – i, stems winged from decurrent leaves; ii, involucre (*Biltmore Herbarium 168b*); **B,** *Cirsium muticum* involucre (*Whitford s.n.*); **C,** *Cirsium horridulum*, with reduced leaves crowded around involucre (*Veerhoff 346*); **D,** *Cirsium arvense* – i, pistillate flower, note long pappus; ii, staminate flower, note pappus shorter than corollas (*Eames s.n.*); **E,** *Cirsium virginianum* involucre (*Godfrey & Fox 51040*); **F,** *Cirsium discolor* – i, deeply pinnatifid leaves; ii, involucre (*Wilbur 4856*); **G,** *Cirsium carolinianum* involucre (*Godfrey & Fox 50388*); **H,** *Cirsium nuttallii* involucre, note dorsal, elongate glutinous ridge on bracts (*R. Westbrooks s.n.*); **I,** *Cirsium lecontei* involucre (*Blair 759*); **J,** *Cirsium repandum* involucre (*Fox 1693*); **K,** *Cirsium altissimum* involucre (Nicholson s.n.); **L,** *Cirsium pumilum* involucre (*Fox 3687*). All specimens from NCSC.

tomentose, older stems and abaxial leaf surfaces glabrate; heads strongly pedunculate _____ **Cirsium lecontei** Torr. & A. Gray (Fig. 1I)

10. Young stems and abaxial leaf surfaces arachnoid-villous, hirsute, or rarely arachnoid tomentose; heads scarcely or more or less strongly pedunculate.
    11. Cauline leaves crowded, the internodes frequently < 1 cm long; inner involucral bracts gradually tapering to a narrowly pointed tip (Fig. 1J) _____ **Cirsium repandum** Michx.
    11. Cauline leaves typically not crowded (although sometimes so near the base); inner involucral bracts with expanded, chartaceous, crisped, and erose tips (Fig. 1L) _____ **Cirsium pumilum** (Nutt.) Spreng.

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Radford, A.E., H.E. Ahles, and C.R. Bell. 1968. Manual of the vascular flora of the Carolinas. University of North Carolina Press, Chapel Hill.

REINSTATEMENT OF *VIBURNUM OZARKENSE* (CAPRIFOLIACEAE): AN ENDEMIC TAXON OF THE INTERIOR HIGHLANDS OF ARKANSAS, MISSOURI AND OKLAHOMA

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ABSTRACT

Based on field work and morphological analysis of herbarium specimens, *Viburnum ozarkense* Ashe is reinstated as a distinct species. Recognition of the occurrence and distribution of *V. ozarkense* has been compromised by its reduction to synonymy under *Viburnum molle* Michx. A morphological characterization of *V. ozarkense* and *V. molle*, a key to species, and a distribution map are provided. This research supports the recognition of *V. ozarkense* as an endemic shrub of the Interior Highlands of Arkansas, Missouri and Oklahoma.

RESUMEN

Basados en trabajo de campo y análisis morfológico de especímenes de herbario, *Viburnum ozarkense* Ashe se repone como una especie distinta. El reconocimiento de la ocurrencia y distribución de *V. ozarkense* ha estado comprometido por su reducción a sinónimo de *Viburnum molle* Michx. Se ofrecen una caracterización morfológica de *V. ozarkense* y *V. molle*, una clave de especies, y un mapa de distribución. Esta investigación apoya el reconocimiento de *V. ozarkense* como un arbusto endémico de las montañas Ouachita y Ozark de Arkansas, Missouri y Oklahoma.

INTRODUCTION

Viburnum ozarkense was described from material W. W. Ashe collected in Stone County, Arkansas with the type locality providing the only distributional reference (Ashe 1928). Ashe was a prolific collector, amassing some 30,000 specimens by his death (Massey 2001). Ashe also published 510 species and varietal names from these collections, but many have been reduced to synonymy (Coker et al. 1932). *Viburnum molle* was described by Michaux from material he collected in Kentucky in the late 1700s (Michaux 1803). Ashe was aware of *V. molle* Michx., and provided characteristics to separate *V. ozarkense* from *V. molle* in his species description. Original material from both of these collections has not been readily accessible to American botanists: the Michaux collection of *V. molle* was deposited in the Paris herbarium (P)(acronyms after Holmgren et al. 1990), and most of Ashe's collections were inaccessible in his private herbaria at the time of his death (Coker et al. 1932).

The name *V. ozarkense* was retained in an early checklist for Arkansas (Moore 1941) and in a generic treatment of *Viburnum* by McAtee (1956). How-

ever, it was reduced to synonymy under *V. molle* Michx. by Steyermark (1963) and this placement has been followed by current treatments (Tucker 1976; Smith 1988; USDA, NRCS 2002). Neither taxon is currently monitored by heritage programs in Arkansas, Missouri or Oklahoma. Based on morphological analysis of *Viburnum ozarkense* and *V. molle*, I recognize these taxa as distinct, provide a key to differentiate them, and map the current distribution of both taxa in Arkansas, Missouri and Oklahoma.

MATERIALS AND METHODS

Loans were requested from herbaria with Ashe collections: A, GH, ILL, L, LCU, MO, NCU, POM, and US, and certain herbaria having Arkansas, Missouri and Oklahoma *Viburnum* material: APCR, BRIT, NA, NYBG, OKL, SMS, UAM, UARK, and UMO. Additional specimens were collected during field work in Arkansas, Missouri and Oklahoma in 1999–2001.

Measurements were recorded for 14 quantitative characteristics: leaf size, toothing, venation, length of leaf tip, petiole length on fertile and vegetative shoots, peduncle length, number of rays, inflorescence width and height, corolla width, stamen length and fruit length and width. Qualitative characteristics including leaf shape, leaf and petiole pubescence, the presence, placement and pubescence on stipules and inflorescence bracts, flowering times and shoot pubescence and color were noted. Mensural and qualitative data were used to prepare a diagnostic key for the species.

Habitat and associate information was gleaned from vouchers and from field work. A distribution map of all known populations of *V. ozarkense* and *V. molle* occurring in Arkansas, Missouri and Oklahoma was prepared from annotated loans and new collections.

RESULTS AND DISCUSSION

Loans resulted in 236 vouchers for study. An additional 119 collections were produced from field work during 1999–2001 in Arkansas, Missouri and Oklahoma. Of these, 193 were referable to *Viburnum ozarkense* and 162 to *V. molle*. They are all listed in the specimens examined section for each taxon.

Mensural results

Mensural analysis indicates that the most useful features for differentiating *Viburnum ozarkense* from *V. molle* are leaf width, number of teeth per half leaf, number of veins per half leaf, leaf tip length, petiole length below an inflorescence or at the apex of a vegetative shoot, corolla width and fruit length. The means of these characters were all statistically significantly different (Table 1). Measured features not significantly different between the species were leaf length, peduncle length, inflorescence width and height, stamen length and fruit width.

Based on my measurements leaves in *Viburnum ozarkense* averaged 7.2 cm wide, with 5.3 veins and 13.9 teeth per half leaf, and had an acuminate apex averaging 7.7 mm long. Leaves of *V. molle* were wider, averaging 8.2 cm broad, with 6.1 veins; more toothed, averaging 25.6 teeth per half leaf; and with an acute apex averaging 2.9 mm long. *Viburnum ozarkense* petioles on both flowering and sterile shoots are shorter than those of *V. molle*. The first petioles below an inflorescence averaged 1.1 cm in *V. ozarkense* and 2.4 cm for *V. molle*. Petioles on the distal ends of vegetative shoots are similarly shorter on *V. ozarkense* shoots ($\bar{x}$= 2.1 cm) than *V. molle* shoots ($\bar{x}$= 3.4 cm). Corollas were significantly wider in *V. ozarkense* flowers ($\bar{x}$= 6.6 mm) than in *V. molle* flowers ($\bar{x}$= 4.4 mm), but these data were derived from a small sample (n= 40). Mature fruits were significantly longer in *V. ozarkense* ($\bar{x}$= 1.1 cm) than in *V. molle* ($\bar{x}$= 0.9 cm), but again, sample size was small (n= 41). Vegetative specimens of these taxa are differentiated based on the number of teeth per half leaf. This characteristic overlaps in only a few individuals with distinct peaks well separated (Fig. 1).

Qualitative characteristics

Qualitative features such as leaf shape, leaf and petiole pubescence, color of current year shoots and bark features also provided useful characteristics to separate the species (Table 1). In outline, *Viburnum molle* leaves are broadly ovate or orbicular; those of *V. ozarkense* are narrower and appear ovate in outline. Adaxial leaf surfaces of *V. ozarkense* are uniformly hirsute, with short hairs (ca. 0.25 mm long) across the surface. In contrast, adaxial surfaces of *V. molle* leaves are glabrous or may have a few scattered red, glandular hairs. Similarly, petioles of *V. ozarkense* are pubescent, covered with moderate to dense strigose and glandular hairs and an open furrow. Petioles of *V. molle* are essentially glabrous and any observed pubescence is typically manifested as a few glandular hairs at the distal end of the petiole or as a few villous hairs along the margin of the closed petiole furrow. Stipules are present in both species; in *V. molle* these occur in single pairs, while in *V. ozarkanse* two pairs of stipules per leaf stalk are often observed. In cross section, *V. ozarkense* petioles appear oval while *V. molle* petioles appear terete. The color of current year shoots at mid-season also provides a useful way to differentiate these taxa. For *V. ozarkense* they are reddish-brown, in contrast to the yellow-tan shoots of *V. molle*. The most obvious field character separating these viburnums is the presence of exfoliating bark persistent on stems after the second year of growth on *V. molle* shoots verses the tight bark throughout the branching of *V. ozarkense*. Although this is a prominent field character, it is not consistently present on herbarium sheets, as many collections do not show enough branch to capture it.

DIAGNOSTIC KEY

Leaves ovate, adaxially hirsute, 8 to 21 (mode 14) marginal teeth per half leaf; petioles of first pair of leaves below inflorescence $\bar{x}$= 1.0 cm, $\bar{x}$= 2.0 cm at tips of vegeta-

TABLE 1. Comparison of characteristics useful in differentiating *V. ozarkense* and *V. molle*. N = number of individuals measured or sampled. Data – range with means and standard deviations in parentheses. * = values significantly different at $p < .05$.

Character	N	*Viburnum ozarkense*	N	*Viburnum molle*
leaf shape	190	ovate	158	broadly ovate, orbicular
*leaf width (cm)	190	4–14 (7.2±1.4)	158	5–12 (8.2±1.3)
*number of veins/ half leaf	192	4–8 (5.4±0.65)	162	5–8 (6.1±0.69)
adaxial leaf surface pubescence	190	hirsute	158	glabrous
*number of teeth/ half leaf	192	8–21 (13.8±2.3)	162	17–44 (25.6±4.2)
*length of 1st petiole below inflorescence (cm)	82	0.5–2.2 (1.1±0.37)	68	1–4.2 (2.4±0.52)
*length of 1st petiole vegetative shoot (cm)	109	0.9–3.4 (2.1±0.56)	90	1.8–4.9 (3.4±0.72)
petiole pubescence	190	strigose and glandular	158	glabrous to sparse glandular
*leaf tip length (mm)	184	3–15 (7.7±2.6)	160	1–7 (2.9±1.1)
*corolla width (mm)	19	4–9 (6.6±1.5)	21	3–6 (4.4±0.78)
*fruit length (cm)	16	0.8–1.3 (1.1±0.15)	25	0.7–1.1 (0.9±0.11)
bark		tight throughout		exfoliating on >2 year old wood
current season shoot color		reddish-brown		yellow-tan

tive shoots, oval in cross-section, moderately to densely strigose and glandular, furrows open; stipules often 2 pair per leaf stalk; shoots of current season reddish-brown; twigs and stems with tight bark throughout _____ **Viburnum ozarkense**

Leaves broadly ovate to orbicular, adaxially g abrous, 17 to 44 (mode 24) marginal teeth per half leaf; petioles of first pair leaves below inflorescence $\bar{x}$ = 2.4 cm, $\bar{x}$ = 3.3 cm at tips of vegetative shoots, terete in cross section, glabrous or sparsely glan dular, furrow closed; stipules in single pairs only; shoots of current season yellow-tan; older (>2 years) twigs and stems with exfoliating bark _____ **Viburnum molle**

Phenology

Flowering material (about 5% each of *Viburnum molle* and *V. ozarkense* vouchers) for the plants that occurred in Arkansas, Missouri and Oklahoma indicated that *V. ozarkense* flowers earlier than *V. molle*. Based on the material I examined, *V. ozarkense* flowered between May 6 and June 7, with a peak flowering time of May 19. *Viburnum molle* flowered between May 15 and May 29, with a peak on May 27–29 (Fig. 2).

Habitat and Associates

Information gleaned from herbarium labels and field experience indicated that *Viburnum ozarkense* and *V. molle* occupied similar habitats and had a similar set of associates. Most associate data were compiled from field notes of the author.

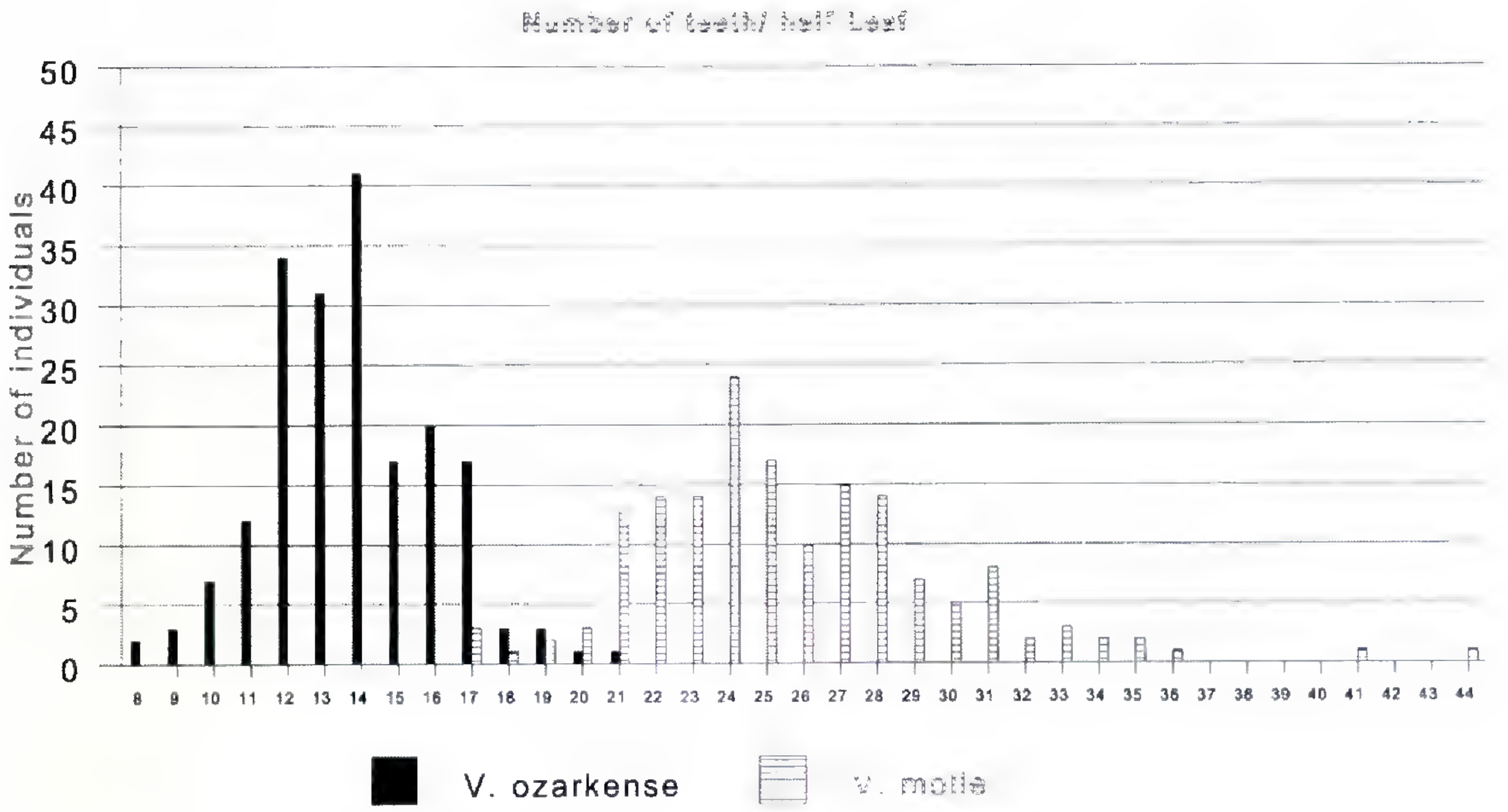


FIG. 1. Number of marginal teeth per half leaf for *Viburnum ozarkense* and *Viburnum molle* specimens collected in Arkansas, Missouri and Oklahoma.

Viburnum ozarkense

Populations of *Viburnum ozarkense* in Arkansas are most often encountered on north-facing ridges, rocky limestone hillsides and wooded slopes in rich woods. It also occurs on ledges and in rocky woods above and along creeks (ex. Alum Fork, Bard Springs, Buffalo River, Cap Fork, Little Red River and Stepp Creek). Associates of *V. ozarkense* in Arkansas include: *Acer saccharum, Arundinaria gigantea, Berchemia scandens, Carpinus caroliniana, Carya cordiformis, Chionanthus virginicus, Cornus florida, Diospyros virginiana, Dirca palustris, Hamamelis vernalis, Hydrangea arborescens, Magnolia acuminata, Philadelphus pubescens, Quercus muhlenbergii, Q. stellata, Rhamnus caroliniana, Rhus aromatica, Sideroxylon lanuginosum, Staphylea trifolia, Tilia americana, Vaccinium arboreum* and *Viburnum rufidulum.*

In Missouri, *Viburnum ozarkense* has been collected from north and northeast facing limestone ledges and bluffs above the Eleven Point River, from limestone slopes along Myatt Creek, and north facing limestone slopes along the South Fork of the Spring River. These are often mid-slope locations with filtered light. Associates of *V. ozarkense* in Missouri included: *Acer saccharum, Berchemia scandens, Carpinus caroliniana, Cornus florida, Fraxinus quadrangulata, Lindera benzoin, Ostrya virginiana, Quercus alba, Q. muhlenbergii, Q. rubra, Sideroxylon lanuginosum,* and *Viburnum rufidulum.*

In Oklahoma, *Viburnum ozarkense* has been collected from a rocky north facing chert slope above Caney Creek in Adair County, and wooded oak-pine hillsides in McCurtain County. Associates of *V. ozarkense* in Oklahoma at the

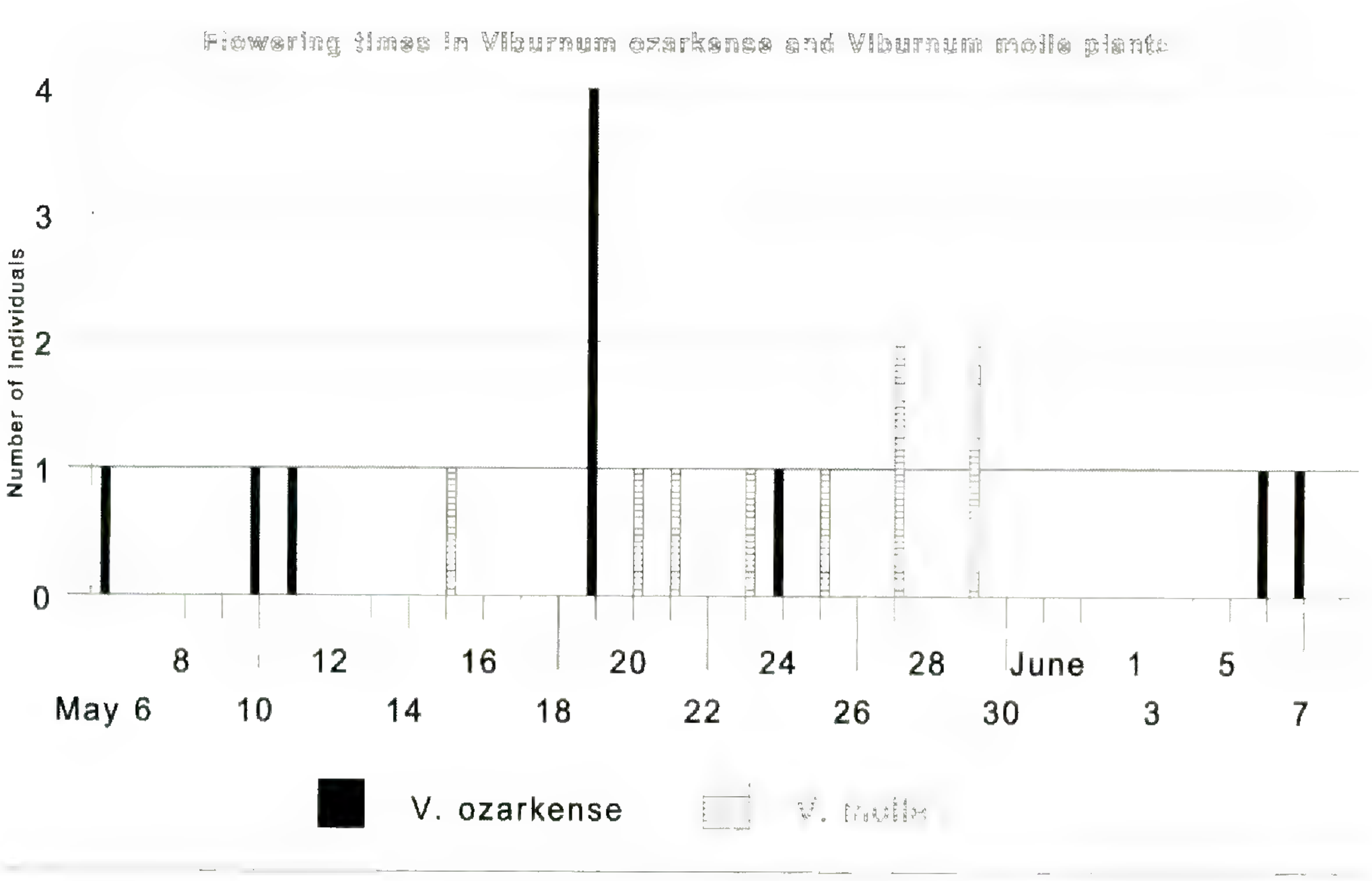


FIG. 2. Flowering phenology of *Viburnum ozarkense* and *Viburnum molle* in Arkansas, Missouri and Oklahoma.

Adair County site included: *Acer saccharum, A. rubrum, Asimina triloba, Cercis canadensis, Corylus americana, Hydrangea arborescens, Lindera benzoin, Nyssa sylvatica, Quercus alba, Sassafras albidum, Staphylea trifolia, Tilia americana* and *Viburnum rufidulum.*

Viburnum molle

Viburnum molle occurs in Arkansas on chert slopes at the base of north facing bluffs along War Eagle Creek in Madison County. A single collection by E.J. Palmer documented *V. molle* in Boone County from "rocky ledges, Harrison." Associates of *V. molle* in Arkansas at the War Eagle Creek site included: *Acer saccharum, Asimina triloba, Hydrangea arborescens, Juglans nigra, Lindera benzoin, Magnolia acuminata, Quercus muhlenbergii, Q. rubra, Staphylea trifolia,* and *Tilia americana.*

Habitats in Missouri which support *Viburnum molle* include north facing slopes, bluffs and limestone ledges along creeks and rivers (ex. Castor River, Cole Camp Creek, Gasconade River, Jacks Fork of Current River, James River, Jonca Creek, Lost Creek, Meramec River, Piney Creek, River Aux Vases, Stinson Creek, Swan Creek, West Fork Cuivre River). Along these creeks and rivers, *V. molle* plants typically occur as understory elements receiving filtered or part day sunlight, at the mid-slope point, neither in the floodplain nor at the more xeric ridge crest. In Missouri associates included: *Acer saccharum, Asimina triloba, Carpinus caroliniana, Cornus florida, Dirca palustris, Juniperus*

virginiana, *Quercus muhlenbergii*, *Sideroxylon lanuginosum*, *Tilia americana*, and *Viburnum rufidulum*.

Viburnum molle is not known to occur in Oklahoma.

Distribution and rarity

Distribution of *Viburnum ozarkense* was compiled from annotated herbarium vouchers and new collections produced for this study (Fig. 3). *Viburnum ozarkense* is confined to the Ouachita and Boston Mountains and Ozark plateau, and is documented from 14 counties in Arkansas, Howell and Oregon counties in Missouri, and Adair and McCurtain counties in Oklahoma. While some populations have been sampled repeatedly over the past 75 years, (ex. type population in Stone Co., Arkansas), others are documented by single collections. Based on herbarium material, 50% of the known populations of *V. ozarkense* have not been sampled for more than 30 years, and some populations not sampled for as long as 80 years. Some Arkansas populations have conservation protection in the Ozark National Forest, and along the Buffalo National River.

Viburnum ozarkense populations in Missouri are afforded some protection at sites along the Eleven Point River in the Mark Twain National Forest. A population examined in 2000, at the western edge of the range in Adair County, Oklahoma, was composed of about 15 individuals and is not known to have conservation protection. The size and conservation status of the McCurtain County, Oklahoma population is unknown; this population has not been sampled since 1966. With a known distribution of 18 counties in three states, *V. ozarkense* clearly falls under the 26 county upper limit for rare southeastern endemics established by Estill and Cruzan (2001). *Viburnum ozarkense* should be considered for state listing in states where it occurs and attempts should be made to locate additional populations.

The commonness or rarity of *V. molle* throughout its range has not been critically reviewed. In Arkansas, *V. molle* is restricted to Madison and Boone counties (Fig. 3). The Madison County population of *V. molle*, was discovered by Shepherd in 1987 while working for the Arkansas Natural Heritage Commission. This population was re-visited in 2001 by Weckman and Shepherd and is estimated to consist of 35–50 individuals. It is on private land with no current conservation protection. An attempt by the author to relocate the Boone County population collected by Palmer in 1914 was not successful in 2000. The terse label information, "rocky ledges, Harrison" gave few clues as to its location. This population may no longer be extant. This research indicates *V. molle* is the rarest *Viburnum* species in Arkansas.

Viburnum molle occurs in 16 counties in Missouri. A population observed in Oregon County in 2001 was estimated to consist of about 12 individuals. Labels typically lack information about numbers of plants in a population; thus sizes of other populations are unknown. In the three state study area, herbarium

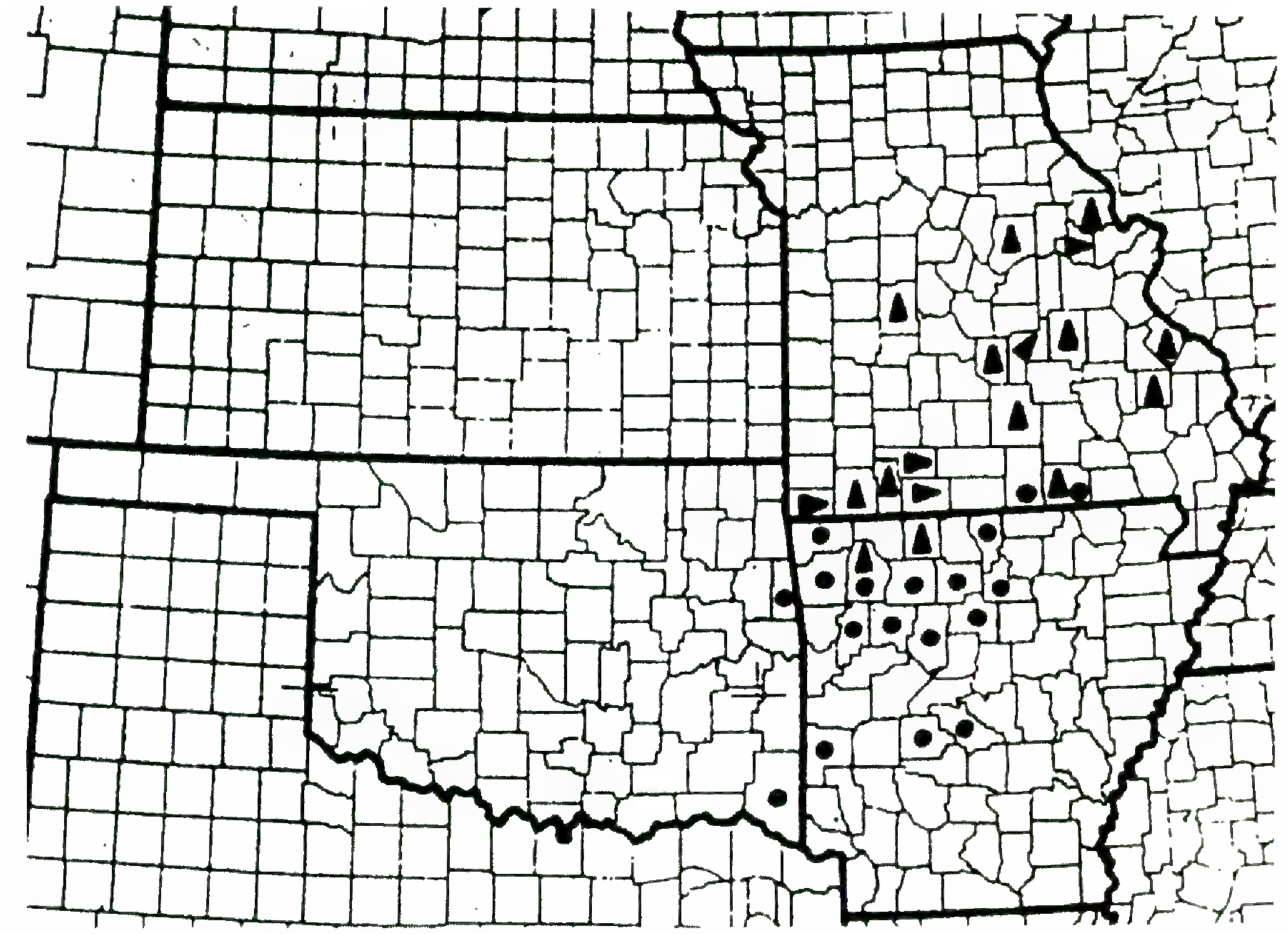


FIG. 3. Distribution of *Viburnum ozarkense* Ashe (●) and *Viburnum molle* Michx. (▲) in Arkansas, Missouri and Oklahoma, based on annotated herbarium vouchers.

vouchers examined of *V. molle* reveal that 50% of the counties were last collected in or before the 1950s. Conservation status of the Missouri populations of *V. molle* are unknown but some may be afforded protection in the various units of the Mark Twain National Forest and along the Eleven Point River.

Overlap of morphology and geographic range

For the mensural characters used in this study, ranges of the measurements overlap, however 8 of 14 characters were statistically significantly different at p= <0.05. If single character taxonomy is desired in the field, the *sine qua non* for *Viburnum molle* is the presence of exfoliating bark and conversely the absence of exfoliating bark defines *V. ozarkense*. This is an inviolate *Viburnum molle* character, used by Michaux in his type description, and observed by the author in the field for plants in Kentucky, Ohio, Missouri, and Arkansas, and on herbarium specimens of *V. molle* through its range in Tennessee, Indiana, Illinois, and Iowa. For determination of herbarium material collected without older stems, the suite of abundantly toothed leaf margins, short apex, and glabrous, terete petioles on yellow-tan twigs would lead one to *Viburnum molle*. Conversely, a specimen with moderately toothed leaves, longer, acute tips, and glandular-

pubescent, oval petioles on reddish-brown twigs would lead one to *Viburnum ozarkense*. These suites of characters allow for the differentiation of these two related species.

Viburnum ozarkense and *V. molle* co-occur in Madison County, Arkansas and Oregon County, Missouri, at the southwest edge of the range of *V. molle* (Fig. 3). In Arkansas the populations are about 30 air miles apart, while in Missouri the populations are about 12 river miles apart. No sympatric populations of *Viburnum molle* and *V. ozarkense* were located by the author, nor were any individuals appearing intermediate between these species observed in the field or voucher material examined.

Specimens examined: **Viburnum ozarkense** Ashe. **ARKANSAS: Baxter Co.:** Baxter Co.: 6 Jun 1931, *Ashe s.n.* (NCU); 7 Jun 1931, *Ashe s.n.* (NCU); 10 Jun 1931, *Ashe s.n.* (NCU, NY). **Benton Co.:** Devils Eyebrow, 22 Apr 1928, *Demaree 4842* (UARK). **Franklin Co.:** Devils Hollow, 3 Jun 1978, *Barber 849* (UAM, UARK). **Garland Co.:** creek banks, Ouachita River, 28 Aug 1939, *Demaree 20517* (MO); Walnut Creek Recreation Area, 10 Aug 1951, *Moore 510786* (UARK); rich woods, Charlton Recreation Area, 23 Apr 1994, *Sundell et al 10759* (NA, UAM). **Johnson Co.:** creek bank, Ozark National Forest, 14 Sep 1995, *Kirshberger & Davis 101* (UAM, UARK). **Madison Co.:** woods understory, S of Red Star, 18 Apr 1995, *Kirshberger 12* (UAM); mesic woods, vicinity Boston, 17 Nov 1973, *Tucker 12461* (SMU) Little Mulberry Creek, S of Red Star, 3 Jun 2001, *Weckman 6401–6419* (EKY). **Newton Co.:** Stepp Creek near Swain, 20 Jul 1979, *Bonar s.n.* (UARK); Boxley, 22 May 1948, *Moore 480226* (UARK); limestone woods above Buffalo River, 20 May 2000, *Weckman 5597A,B- -5599* (EKY); upland woods Buffalo River, near Boxley, 20 May 2000, *Weckman 5603* (EKY). **Polk Co.:** creek banks, Bard Springs, 4 May 1955, *Demaree 36632* (SMU). **Pope Co.:** Snow Creek, N of Hector, 31 Oct 1978, *Boatright & Utley 102* (APCR); along creek bank, Hector, 17 Oct 1932, *Merrill 89* (A); creek bank, Nogo, 11 May 1933, *Merrill 271* (ILL, MO, UARK); rugged hills NE of Russellville, Aug 1955, *Moore et al 55-432* (UARK); rich woods along Indian Creek, SW of Pelsor, 10 May 1969, *Tucker 7926* (APCR). **Saline Co.:** bluffs, Alum Fork, Saline River, 28 May 1954, *Demaree 35333* (NCU, US); the Narrows, S of Crows, 24 Sep 1995, *Sundell & Pagan 11726* (UAM); narrow ridge, Saline River, 11 Jul 1997, *Walker 11079701* (UARK); N face slope above Alum Fork, 6 Jul 1999, *Weckman & Walker 5110, 5111,5113,5131* (EKY). **Searcy Co.:** rocky creek bluff, Harriet, 9 May 1970, *Demaree 61712* (MO); hillside, S of Marshall, 29 Apr 1967, *Graham 343* (NCU). **Stone Co.:** near Sylamore, n.d., *Ashe s.n.* (NCU); near Sylamore, 18 May 1924, *Ashe s.n.* (NCU); bottom of N Sylamore Creek, 7 Jun 1931, *Ashe s.n.* (NCU); along Cap Fork Creek, 6 May 1981, *Davis 2975* (APCR); creek bottom in woods, Mountain View, 10 May 1952, *Demaree 31751* (US, VDB); rocky hillsides, Blanchard Springs, 19 May 1952, *Demaree 31850* (NCU, US, VDB); rocky open woods, bluffs, Sylamore Creek, 19 May 1965, *Demaree 52296* (NCU); Barkshed Recreation Area, along N Sylamore Creek, 29 Apr 1967, *Graham et al 343* (APCR); Blanchard Springs, 18 Jun 1945, *Moore 450600* (UARK); Sylamore, 24 Jun 1945, *Moore 450629* (UARK); Sylamore Forest, 24 Jun 1945, *Moore 450646* (UARK); Blanchard Springs, 23 Jun 1945, *Moore 450721* (UARK); Blanchard Springs, 18 Aug 1948, *Moore 480735* (UARK); Caney Creek, N of Mt. View, 21 Jun 1951, *Moore 510347* (UARK); wooded N facing slope, Gunner Pool Recreation Area, 19-21 May 1978, *Redfearn 31673* (SMS); Big Creek, 9 May 1970, *Smith 1462* (UARK); above creek bed, vicinity of Blanchard Springs, 22 May 1984, *Sundell 6308* (UAM); along Sylamore Creek, 8 Oct 1966, *Tucker & Demaree 3578* (APCR); alluvial woods, Barkshed Recreation Area, 14 Oct 1967, *Tucker 6862* (APCR); alluvial woods along N Sylamore Creek, 14 Oct 1967, *Tucker 6867* (APCR, NCU); streamside, Blanchard Springs Recreation Area, 2 Oct 1969, *Tucker 8225* (APCR); rocky streambank, Blanchard Springs, 5 Aug 1972, *Tucker 10418* (UARK); rocky slope, Gunner Pool, 5 Aug 1972, *Tucker 10449* (APCR); along N Sylamore Creek, 8 Oct 1972, *Tucker 10605* (APCR - 2x, SMU, VDB); Cap Fork, Barkshed Recreation Area, 7 Jul 1999, *Weckman 5151, 5160–5168* (EKY); Blanchard Springs,

7 Jul 1999, *Weckman 5172–5176, 5178–5184* (EKY). **Van Buren Co.:** sandstone bluffs, Little Red River, near Shirley, 28 May 1924, *Palmer 25197* (A, MO, UARK). **Washington Co.:** Cove Creek Valley, 17 Aug 1954, *Hite 102* (UARK). Unknown Co.: Arkansas, n.d., *anon. sn*, (NCU).

MISSOURI: Howell Co.: limestone slopes along Myatt Creek, 27 Apr 1938, *Steyermark 5186* (F, MO); lime bluffs, Eleven Point River, 12 Aug 1934, *Steyermark 14503* (MO, NA,US); shaded lime bluff, Eleven Point River, NE of Peace Valley, 12 Aug 1934, *Steyermark 14503A, 14503B* (UMO); Eleven Point River near Blowing Springs, 14 Apr 1935, *Steyermark 18614* (UMO); S Fork Spring River, 26 Jun 1955, *Steyermark 78762* (UMO); N face limestone slope, S Fork Spring River, 26 Jun 1955, *Steyermark 78763* (UMO); limestone bluffs, S Fork Spring River, 26 Jun 1955, *Steyermark 78765* (GH, MO, UMO); along S Fork Creek, 19 Jul 1979, *Summers 527* (MO); ledges, bluff, dolomite glade, SE of Mt. View, 27 Jun 1990, *Summers 3394* (MO); N face dolomite bluff, S Fork Spring River, 4 Jul 1990, *Summers 3431* (MO); N face dolomite bluff, S Fork Spring River, 4 Jul 1990, *Summers 3432* (MO); Eleven Point River at Blowing Springs, 14 Sep 1994, *Summers 7102* (MO); Eleven Point River at Blowing Springs, 2 Jun 2001, *Weckman 6360–6365, 6371–6385* (EKY); S Fork Spring River, N of Lanton, 2 Jun 2001, *Weckman 6390–6393* (EKY). **Oregon Co.:** SW facing dolomite glade and bluff, 4 Aug 1993, *Summers 6170* (MO).
OKLAHOMA: Adair Co.: rocky hillside, 14 May 1980, *Huft & Goodman 1160* (OKL); chert slope above Caney Creek, 27 Apr 1968, *Perino & Pierson 168* (OKL); NW of Stilwell, 13 Jun 1957, *Rice s.n.* (GH, OKL, OKLA); NE of Stilwell, 2 May 1959, *Rice s.n.* (OKLA); chert slope above Caney Creek, 19 May 2000, *Weckman 5577--5587* (EKY). **McCurtain Co.:** oak-pine woods in mountains, S of Bethel, 9 Aug 1948, *Waterfall 8515* (OKL, OKLA); wooded hill, S of Bethel, 4 Jun 1949, *Waterfall 8826* (OKLA); open woods, base of mountains, N of Broken Bow, 24 Jun 1966, *Waterfall 17228* (NCU, OKLA).

Viburnum molle Michx. **ARKANSAS: Boone Co.:** rocky ledges, Harrison, 25 Oct 1914, *Palmer 6914* (A, MO, US). **Madison Co.:** ledge, limestone bluff, War Eagle Creek, 15 May 1987, *Shepherd & Smith 286* (UARK); base of bluff, War Eagle Creek, N of Huntsville, 4 Jun 2001, *Weckman & Shepherd 6420–6441* (EKY). **MISSOURI: Barry Co.:** wooded slopes of Piney Creek, 22 Jun 1937, *Steyermark 22597* (A, F, MO). **Benton Co.:** bluffs of Cole Camp Creek, 28 May 1896, *Demetrio s.n.* (MU, NCU, US); bluffs of Cole Camp Creek, vicinity of the Big Cave, 27 May 1897, *Demetrio s.n.* (GH); Cole Camp Creek, May 1905, *Fullgraf sn* (MO); Cole Camp Creek, 30 Aug 1896, *Heck s.n.* (GH); Bluffs of Cole Camp Creek, vicinity of Big Cave, 9 May 1897, *Heck s.n.* (GH); N facing slopes, ledges, Big Cave bluff, 2 Oct 1924, *Palmer 26370* (A, GH, MO, MOR, UMO); N facing ledges, Big Cave bluff, 12 May 1926, *Palmer 30061* (A, MOR, UMO); bluffs, Cole Camp Creek, 24 Sep 1938, *Steyermark 7289* (F); Cole Camp Creek, 19 May 1904, *Trelease 4* (A); Big Cave, Cole Camp Creek, 12 Jul 1897, *Trelease 383* (NCU); Big Cave, Cole Camp Creek, 12 Jul 1897, *Trelease 384* (A, MO); Cole Camp Creek, n.d., *anon. s.n.* (A). **Callaway Co.:** N. limestone slopes along Middle River, 12 Sep 1937, *Steyermark 26203* (F, MO) steep slopes, Stinson Creek, 12 Sep 1937, *Steyermark 26235* (F, MO); N slopes, Stinson Creek, 25 May 1948, *Steyermark 65464* (F). **Christian Co.:** along Billin Creek, 28 Sep 1905, *Bush 3480* (A, MO); rich woods, 21 May 1907, *Bush 4625* (A, MO); bluffs, Swan Creek near Garrison, 28 Oct 1955, *Palmer 61802* (UMO); N facing wooded slope along Woods Fork, 9 May 1981, *Redfearn 32647* (SMS, UMO); E and NW facing bluffs, Swan Creek, 6 Jul 1937, *Steyermark 23039* (F, NY). **Crawford Co.:** rocky woods along stream, Zahorsky Woods, 25 Aug 1983, *Christ s.n.* (MO); cliff base, Meramec River, 12 Sep 1986, *Rogers 216* (MO); hillside near Steelville, May 1929, *Shoop s.n.* (UMO); lime bluffs, Meramec River, 21 Oct 1934, *Steyermark 16317* (MO, US); lime bluffs, SE of Bourbon, 21 Oct 1934, *Steyermark 16317A, 16317B* (UMO); steep slopes, Meramec River, 15 Jun 1941, *Steyermark 41332* (F, GH); steep slopes S side Meramec River, 15 Jun 1941, *Steyermark 41339* (F, GH, MO, US); base of slope, Meramec River, 15 Jun 1941, *Steyermark 41341* (F, GH); NE face, Meramec River, 11 Jun 1955, *Steyermark 78602* (UMO). **Lincoln Co.:** N face bluffs W Fork Cuivre River, 28 Apr 1941, *Steyermark 28516* (F, GH, MO); **McDonald Co.:** rich hillsides, Noel, 25 Apr 1909, *Bush 5531* (A); rich woods, Noel, 27 May 1909, *Bush 5763* (A). **Madison Co.:** limestone bluff, outcrops, Castor River, 27 Aug 1948, *Steyermark 66097* (F). **Oregon Co.:** limestone bluffs, Eleven Point River, 1 May 1986, *Summers 1589* (MO); Cane Bluff, Eleven Point River, 1 Jun 2001, *Weckman 6350–*

6359 (EKY). **Pulaski Co.:** N facing limestone slopes, Gasconade River, 24 Aug 1937, *Steyermark 25268* (F, MO); N limestone bluffs, Gasconade River, 10 Sep 1956, *Steyermark 82532A, 82532B* (UMO). **Phelps Co.:** N facing bluff, Gasconade River, 2 May 1991, *Summers 4248* (MO). **St. Genevieve Co.:** talus slopes, ledges, Jonca Creek, 17 Jun 1993, *Brant 2398* (MO); NW facing lime bluff, River Aux Vases, 6 Jul 1946, *Steyermark 63872* (F); NW facing lime bluff, River Aux Vases, 6 Jul 1946, *Steyermark 63873* (F). **Stone Co.:** cliffs of James River, 15 Oct 1913, *Palmer 4671* (A, US); high limestone bluffs, James River, 20 May 1914, *Palmer 5671* (NY, US); high limestone bluff, James River, 11 Sep 1918, *Palmer 14361* (A); high limestone bluffs, James River, 17 Apr 1920, *Palmer 17226* (A); N high lime bluffs, James River, 23 May 1923, *Palmer 22816* (A, MO, MOR, UMO, US); high limestone bluffs, James River, 24 Sep 1923, *Palmer 23872* (A, SIU); high limestone bluffs, James River, 24 Sep 1923, *Palmer 23872a* (A, MOR); N face, limestone ledges, James River, 16 Sep 1924, *Palmer 26158* (A, MOR); N face limestone bluffs, James River, 16 Sep 1924, *Palmer 26158a* (A, MO, MOR); mesic forested dolomite bluff, James River, 23 Jun 1988, *Smith 2733* (MO, SMS); wooded bluff along James River, 22 Jun 1941, *Steyermark 40133* (F). **Taney Co.:** bluffs along Swan, 9 Oct 1899, *Bush 798* (GH, MO, NCU, ND-G, NY, US); rich banks, Swan, 26 Sep 1905, *Bush 3449* (A, GH, NY, US); cliffs of Swan River, 8 Oct 1894, *Sargent s.n.* (A). **Texas Co.:** Jacks Fork, Current River, 26 Aug 1939, *Bauer 867* (F); rocky slopes, dolomitic bluff, Jacks Fork, 1 Aug 1969, *Redfearn et al 899* (MO, NCU, SMS); lime bluffs, slopes, Jacks Fork Current River, 15 Aug 1934, *Steyermark 14574* (GH, MO); lime bluffs, slopes, Jacks Fork Current River, 15 Aug 1934, *Steyermark 14574A, 14574B* (UMO); N face limestone bluff, N Prong of Jacks Fork, 27 Apr 1952, *Steyermark 73117* (F, UARK); N face dolomite bluff, Jacks Fork, 21 Aug 1990, *Summers 3625* (MO). **Warren Co.:** Lost Creek State Forest, 4 Jun 1987, *Christ s.n.* (MO); limestone bluffs along Lost Creek, 9 Jun 1946, *Steyermark 63705* (F).

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CELEBRATION HONORS PIONEER FIELD BOTANIST ANDRÉ MICHAUX

William R. Burk

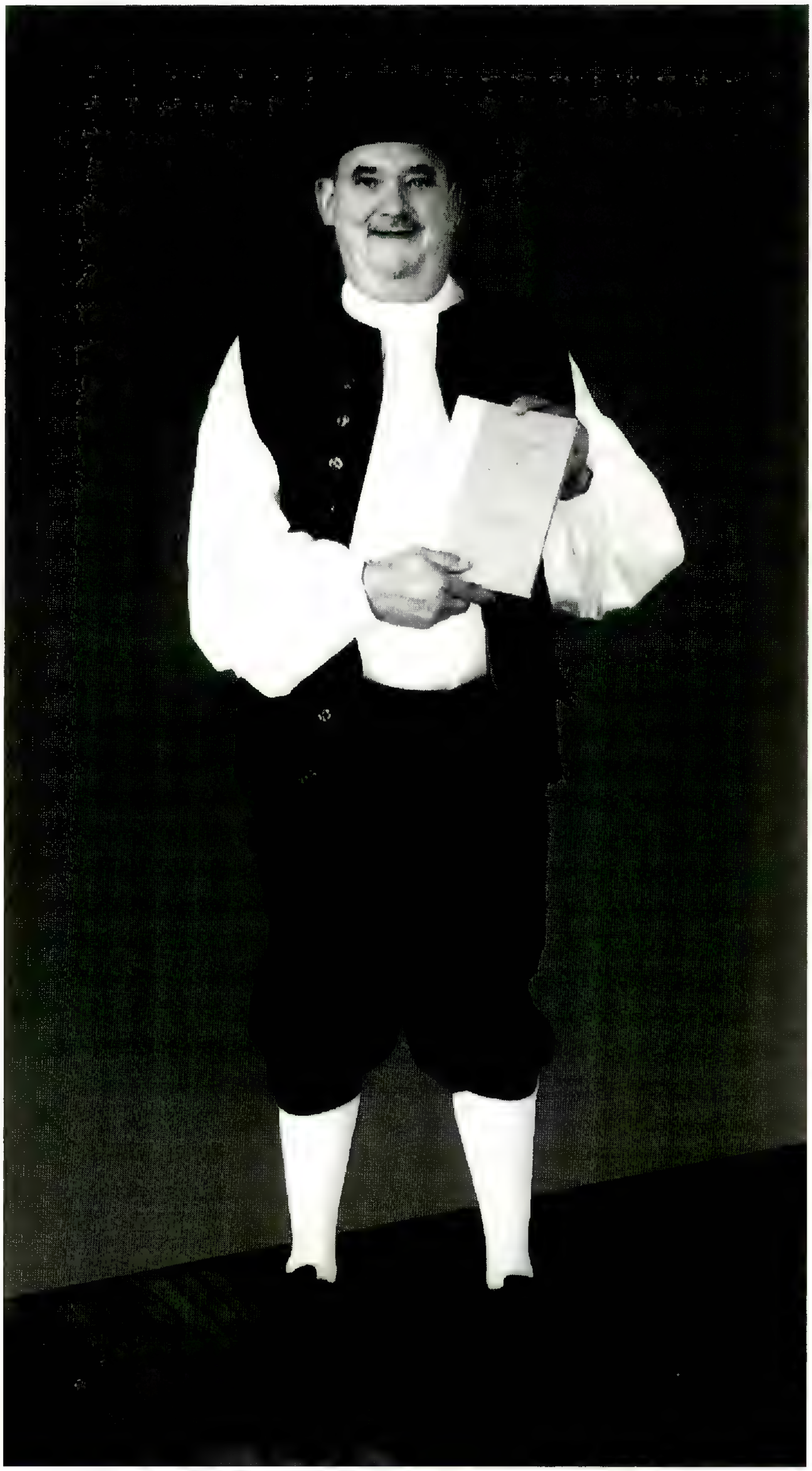
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André Michaux, noted 18th century North American plant explorer extraordinaire, died on the island of Madagascar two hundred years ago. On the occasion of the bicentennial of his death, Michaux's life and contributions to North American botany were highlighted and elucidated at "A Michaux Celebration," attracting nearly 4,000 people. The events began with the André Michaux International Symposium (AMIS), held May 15-17, 2002 in Gaston County, North Carolina. The subsequent two days—called "Celebrate France! Festival Foire!"—occurred at the Daniel Stowe Botanical Garden, a relatively young garden with strong public programs. AMIS constituted the official symposium for the Southern Appalachian Botanical Society (SABS), held for the first time separately from the Association of Southeastern Biologists' annual meeting. Belmont Abbey College (BAC), the Daniel Stowe Botanical Garden (DSBG), and Gaston Day School (GDS) were the hosts of the celebration, three years in the planning. Librarian Charlie Williams was the key architect and organizer of the Celebration, whereas Jeanne Miller was the coordinator. Michael J. Baranski (SABS) served as Program Chair for AMIS. Others were Carol Brooks, Dean de la Motte & Robert Tompkins (BAC); Mike Bush (DSBG); Martha Mayberry (Mint Museum of Charlotte); Richard Rankin (GDS); and Jean-Pierre Riviere (French-American Chamber of Commerce, NC).

Setting the tone for the first day were two field trips, enticing and piquing attendees' curiosities and expectations of Michauxiana to come. That evening ethnobotanist Mark Plotkin delivered the opening address at the Gaston Day School. We learned about the importance of natural products from tropical Brazil and Surinam, such as a potential painkiller from the poison dart frog. He emphasized the need for a holistic approach to conserving tropical flora and fauna. Just as pioneer Michaux persevered under the rigors of exploration, conservation efforts require persistent leadership under equally challenging circumstances.

The fast-paced sequence of 28 fact-packed presentations of May 16 and 17, enlightened our knowledge of Michaux. James L. Reveal, historian of botany, delivered the plenary talk, "No Man is an Island: The Lives and Times of André Michaux." After placing into perspective the accomplishments of naturalists prior to Michaux's arrival in the United States, he discussed Michaux's contri-

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Walter K. Taylor as André Michaux at AMIS, 16 May 2002, Belmont Abbey College, Belmont, North Carolina. (Photograph by Ronald L. Stuckey, Columbus, Ohio)

butions to field botany. Subsequent paper presentations were of two types: invited (9) and contributed (19). Two other scheduled papers on "The Lowcountry Connection of André Michaux" and "Nature and History of the Botanical Materials of André Michaux in the Herbarium of the Academy of Natural Sciences of Philadelphia" were not presented.

Each presentation was virtually unique in topic, overlapping little with others. Among the varied themes on Michaux and his activities, were: his connection with the Bartrams of Philadelphia; his Canadian journey; several accounts on plants—named as new to science by him—including *Magnolia macrophylla*; the rediscovery of the site of his botanical garden in Charleston, South Carolina by archaeologists from the College of Charleston; his involvement with the intriguing Edmund Charles Genet Affair in American history; and his excursion to Madagascar where he died on October 11, 1802 (confirmed by a newly discovered death certificate from Mauritius). When speaker/author Walter K. Taylor gave his talk on Michaux in Spanish East Florida during 1788, he appeared in a period costume, eliciting surprise and delight from the audience. In closing the symposium, Françoise Winieska, noted photographer of gardens and plants representing France at the program, gave a slide presentation, "18th century French Gardens in the Domains of Versailles and Rambouillet," sharing her striking photographs with the captivated viewers.

Additional field trips were held during the symposium and at its conclusion. We enjoyed two dinners at the Stowe Botanical Garden, the evening of May 16 being a "French Gala" of cuisine, eighteenth century period music and dance. On the last evening of AMIS a special treat was an exhibit of engravings and watercolors by eighteenth century botanical artist Pierre-Joseph Redouté at the Mint Museum in Charlotte. Opening in March 2002, the exhibit was specially developed as an adjunct to the Michaux symposium and included five associated talks, among them, "Botanical Illustration: Redouté and the Michaux," by librarian/historian Ian McPhail. The exhibit will close this year on Bastille Day, July 14.

During breaks and other free periods of time, attendees were lured by exhibits, such as the book displays by the Missouri Botanical Garden and by symposium speakers and other participants. Among the latter were books and audio-cassettes by C. Ritchie Bell; Gail Fishman; Walter K. Taylor and Eliane M. Norman; and Charlie Williams. Locally produced and limited in distribution, the booklet "Memoirs of the Life and Botanical Travels of André Michaux," by J.P.F. Deleuze is of special note to librarians and historians. Conceived and edited by Charlie and commemoratively published for the symposium, it contains four appendices, among them a supplementary bibliography by Ronald Gilmour. Charlie's role as editor is a misnomer of the extent of his contribution, as he is also the writer of two of the appendices. The Catawba Lands Conservancy prepared the useful color map folded in the back of the text. The map traces nine journeys that Michaux made in North America from 1787 to 1796.

The publication is available only from Charlie Williams, 6720 Wheeler Drive, Charlotte, NC 28211. Checks are to be written for $16.50 (which includes postage/handling) to "Belmont Abbey College." Artist and school administrator Erin Whitener had a popular display of her line of note cards, featuring color illustrations of plants discovered by Michaux, which sold out early in the program. Her design of the *Magnolia macrophylla*, leaf or fruit, appeared on symposium stationery, handouts, and tote bags given to attendees

Two AMIS booklets in our orientation bags may be of interest to others, particularly librarians. These were an "Attendee Roster" containing names, titles, addresses, phone, fax, and email addresses of all attendees; and "Abstracts," providing succinct summaries of each presentation. Fortunately, the proceedings of AMIS are planned to be published in *Castanea* and its *Occasional papers*.

The French Festival featured special talks, French cuisine, and vendors of merchandise such as artwork, jewelry, and Limoge porcelain. This Festival was open to the public and included activities for children such as face painting, games, and guignol (a Punch and Judy show). Sponsored by the French-American Chamber of Commerce (NC), this event took place at the Stowe Garden on May 18 and 19.

The Michaux Symposium is a model for future theme-type conferences. Both the Symposium and the highly popular "Celebrate France!" were resounding successes. The fervor of symposium goers was evident as noted by conversations sparked by the presentations and scholarly interests of those in attendance. Special thanks are extended to the organizers, hosts, and myriad behind-the-scenes people for bringing together such a distinguished assemblage of Michaux scholars and providing a wide array of events.

Historians of botany will have access to a collection of information sheets and brochures available at the conference that have been assembled by The Ohio State University botanist Ronald L. Stuckey. He has deposited the compilation in the Hunt Institute for Botanical Documentation, Pittsburgh. This contribution also includes all of the photographs he took of the invited speakers participating in AMIS.

The symposium will be a lasting contribution to the history of botany, bringing visibility and recognition to the great botanical pioneer André Michaux. "Celebrate France!" accentuated the important French contribution to American culture. "Celebrate Michaux" merged science and culture to make for a fascinating five days of learning and entertainment. Vive Michaux! The influence of Michaux also was recently recognized by the NC Department of Highways, which landscaped an intersection of Interstate 85 in Gastonia with plants first discovered by Michaux. The plot is identified with a permanent marker.

ACKNOWLEDGMENTS

Ronald L. Stuckey, The Ohio State University, Columbus, assisted with writing the paper (May 24, 2002).

DEL WENIGER (1923-1999), REMARKABLE TEACHER AND NATURALIST

Marjorie Fohn Epler

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In 1960, Del Weniger joined the faculty of Our Lady of the Lake College in San Antonio, Texas.

He was later to become the chairman of the Biology Department. After teaching general biology and ecology for nearly forty years, Del retired from O.L.L. in 1988 as Professor Emeritus.

Although born in Kingman, Kansas, Del thought of himself as an adopted Texan. Appropriately so, since he researched the plants and animals of the state for half a century, this resulting in numerous published articles, and his first two books, Cacti of the Southwest and Cacti of Texas and Adjacent States. The first book received, in 1970, Theta Sigma Phi's "Author of the Year's Best Book By A Texas Publisher" award, as well as accolades from numerous organizations and reviewers. *Echinocereus wenigeri*, a Texas cactus was named for him.

His first two books were followed by Explorers Texas, Vol. I, which the Texas Historical Commission judged to be the "Best Historical Publication of 1984." Vol. II of the series soon followed. Volumes III and IV were in progress at the time of Del's death. He also co-authored the book, San Antonio in the Eighteenth Century, which received the Texas Historical Commission's 1978 "Official Texas Award For The Best Publication of the Year in Local or Regional History."

Del spent many hours researching whatever was written down by the early explorers and pioneers of Texas. His family and friends remember the great pleasure he took in finding new journals or letters of early explorers or settlers who recorded what they saw as they traveled Texas. His deep sense of stewardship of the earth and its gifts was evident in his teaching, his lectures, his volunteer work, and his ecological consultation for federal and local agencies. He stressed responsible, respectful use of our natural heritage as he served as a founding member of the San Antonio Botanical Center, and on local, state and regional boards of the Nature Conservancy and Sierra Club.

A thorough-going naturalist with a respect for all forms of life, Del exhibited an educator's affection for those of his students who demonstrated enthusiasm for the study of biology. As a former student I can attest to his effectiveness in teaching both the fundamentals of ecology and the delight of field work associated with such studies. Professor Weniger loved teaching as much as he loved learning and always took extra time for a student's interest or inquiry.

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Those of us who were familiar with Del Weniger's dedicated working habits and regular good humor were amazed to learn, upon his death, that he had been living, since birth, with an illness called Eisenmenger Complex, a condition whereby a person is born with only a 3-chambered heart. Medical experts think that, because of the heart having to work so much harder, one's life expectancy is lowered to less than 40 years. Delbert Kenneth Weniger, born May 10, 1923, died at the age of 76 on July 10, 1999.



Del Weniger (1923-1999)

Book Reviews

The National Biodiversity Team of the Republic of the Marshall Islands. 2000. **The Marshall Islands, Living Atolls Amidst the Living Seas: The National Biodiversity Report of the Republic of the Marshall Islands.** (ISBN 982-9045-02-1, pbk.) St. Hildegard Publishing Company. Santa Clarita, CA 85719, U.S.A. Price not given, 345 pp, numerous illustrations, 8 1/2" × 11".

During the Earth Summit in Rio de Janeiro, Brazil in 1992, the Republic of the Marshall Islands was among the first to sign the Convention on Biodiversity. Consequently, the Republic sanctioned a report on the biota of its atolls with the hope of raising public awareness to the various aspects of biodiversity. The goal of this report is to "provide background about the Marshall Islands, its history, especially in relation to plants, animals and ecosystems, to give an overview of its biodiversity and biological resources" (p.3). It is mainly a compilation of biological information previously published by other scientists, place in a single format, thereby making it more accessible to the residents of the Marshall Islands. Even the writing style is informal, "with the idea of making the information available to all sorts of people, even high school students."

While on the surface this book might seem appropriate for only a small target audience, only a brief look into this book reveals many informative features. Many of the organisms are illustrated, such as the reef crab and giant grouper, with the Marshallese name and derivation provided. Text boxes featuring a special topic present important biological concepts. A section on "What is a Coral" informs the reader about the different groups of corals and coral-like organisms. Likewise, a section on endemism defines the topic and the term "invasive species" is discussed in some detail.

The first part of the book is comprised of three chapters, which deal with the history of the Marshall Islands and its people, biological resources, and threats to biodiversity. Chapter one begins with a short historical account of the Marshall Islands and its people, history about the formation of the Marshall Island atolls and their relatively recent colonization by terrestrial life only 3,000-4,000 years ago. Furthermore, the detrimental effects people have had on the atolls, with the introduced plants and animals they brought, has resulted in the extinction of several species, including the endemic flightless Wake rail, the purple-capped fruit dove and the Micronesian pigeon. The history of government reveals that the Marshalls have been under the control of several countries, including Germany, Japan and the United States, before becoming their own commonwealth in 1990 and joining the United Nations. This chapter also provides information on the individual atolls comprising the Marshalls, with the Marshallese names of each, the number of square land miles they occupy, and brief historical information.

Chapter two, entitled "Biodiversity and Biological Resources," gives a brief overview of the ecosystems on the Marshall Islands, listing each by plant community and including information on location, importance, status and threats. Following is a concise overview of the biota of the Islands, divided into plants and animals, with tables to give quick information about total number of species, percent native species, percent endemism, number of threatened and endangered species, etc. The fragility of these islands and invasive nature of newly arrived exotics is evident in these tables, since only 18% of vascular plants and 23% of animals are native.

Chapter three deals with current and historical threats to biodiversity, which include nuclear testing, the invasion of exotics, changes in population and lifestyle of the native people and global climate change.

The second half of the book is dedicated to tables and lists of biota. Separate tables are included for plants, pulmonate and non-marine mullosks, spiders, insects, fish, reptiles and amphibians, birds, and mammals. For each of the species in these tables, scientific name, English name, Marshallese

name, status and traditional uses are reported. Next, information on biota deemed worthy of conservation concerns with definitions of conservation terminology (example: threatened vs. endangered). In addition, a table of endemic species, one on pestiferous and invasive species and those species protected by Marshall Island law ease the reader in identifying biota of critical importance. Illustrations are found throughout the book, often with scientific and Marshallese name, and five color figures with keys to identify the organisms in an important community, such as a coral reef. These illustrations enhance the book's properties, helping reader appreciate the biodiversity on the Marshall Islands.—*Amy Trauth Nare, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX, 76102 U.S.A., amy_trauth@yahoo.com.*

CHARLES H. SMITH. 2000. **Biodiversity Studies: A Bibliographic Review**. (ISBN 0-8108-3754-4, hbk.) Scarecrow Press, 4720 Boston Way, Lanham, MD 20706. U.S.A. http://www.scarecrowpress.com (Orders: The Rowman & Littlefield Publishing Group, 15200 NBN Way, Blue Ridge Summit, PA 17214-0191, U.S.A., 800-462-6420). $69.00, 449 pp, 5 1/2" × 8 1/2".

Charles H. Smith, Science Librarian and Associate Professor of Library Public Services at Western Kentucky University, cites literature both on the biological study of diversity itself, and on the socio-natural science of diversity conservation. His effort has received two very prestigious recognitions. His work was listed in *Library Journal*'s Best Reference Sources for 2000, and it won the biannual 2001 Oberly Award for Bibliography in the Agricultural or Natural Sciences.

Two bibliographies are included in this work. Bibliography I, "Books and Articles," lists approximately 1,200 monographs and 4,500 articles, while Bibliography II, "Special Issues," provides a selective accounting of special issues of journals/serials dealing exclusively with biodiversity in all aspects. His emphasis is on the literature of the investigation of biodiversity, the written record of efforts to measure, understand, monitor, and preserve it. Some self-imposed restrictions had to be considered during his exhaustive literature search, which included over one hundred electronic databases and an equal number of print bibliographies and references cited lists. Because of space limitations individual papers appearing in edited collections were excluded, as were electronic sources, theses, dissertations, reference works, systematic or floral/faunal revisions, and juvenile literature. Almost every entry in the list is in the English language. What is featured is the primary literature of biodiversity-directed natural science, social science, and humanities subjects, with a select amount of science journalism. Coverage centers on the period 1986 to 1998, but extends to many works published prior to that date that remain relevant to trends occurring during it.

His basic goal was to provide as much information as possible in as little space as possible for each entry. Each citation is enhanced with bibliometric ratings, brief annotations, and/or a list of descriptive "added terms." The bibliometric rating for journals appears as a 1 to 3 scale according to the average number of times they have been listed as cited over a several- to ten- or twelve-year period in the combined *Citation Index* portions of *Science Citation Index, Social Sciences Citation Index,* and *Humanities Citation Index*. Monographs are rated on the same 1–3 scale but on three different factors: (1) the number of OCLC libraries who hold the item; (2) number of times the work was reviewed after publication, and (3) number of citations it has generated. Both ratings appear in brackets after the pagination in the citation. An "Honors" list appears in his introduction for the ten most frequently mentioned publishers and the twelve serial publications most frequently cited. The addition of the bibliometric ratings makes this bibliography not only unique but also especially useful due to its analysis of the relative importance or value of each entry.

The three indexes, covering general, geographical, and organismal subjects, respectively, generate over 20,000 referrals to the items in the bibliography. Index I is alphabetically arranged by subject. Index II is divided into nine regional lists. Index III contains nine taxonomic lists. The indexing features many cross referrals because so many of the significant concepts in the developing field

of biodiversity are associational. The other major feature of the indexes derives from the bibliometric approach taken in Bibliography I. Item numbers in the Indexes that are underlined represent works which were rated with the higher scores. This feature will make it easier to prioritize readings. The work also surveys closely related topics from such allied fields as environmental ethics, nature philosophy, environmental law, agricultural ecology, evolutionary biology, biometrics, sustainable development, environmental policy, forestry, genetics, education, climatology, and paleobiology. It provides a good overview of important research and will make the literature review process easier.

While "Biodiversity Studies: A Bibliographic Review," is highly recommended for scientists, educators and professionals-to-be, it cites a fair amount of material that can be understood by undergraduates or even high school students. This book would be a valuable addition to library reference collections and should be in all graduate and professional library collections.—*Gary L. Jennings, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A.*

MARY TOOMEY and EVERETT LEEDS. 2002. **An Illustrated Encyclopedia of Clematis.** (ISBN 0-88192-508-X, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $59.95, 428 pp, 652 color photos, 5 b/w illustrations, 151 line illustrations, 2 maps, 8 1/2" × 11".

An Illustrated Encyclopedia of Clematis was written by distinguished Clematis experts Mary Toomey and Everett Leeds and supported in spirit and publication by the British Clematis Society. Their goal was to produce a reliable, substantial and definitive work on the genus. This comprehensively illustrated work will meet those needs, particularly of passionate gardeners, hybridizers, and nurseries.

The popularity of the genus *Clematis* as a garden plant rose dramatically in the 1990s in part because of the extraordinary diversity of its flowers and in part because gardeners were exposed to a better and wider range of large flowered cultivars from all corners of the world. Clematis, be they cultivars or species, can also be found in bloom almost every month of the year. Add the astonishing range of flower color and the size and shape of the flowers and it becomes apparent why clematis has been justifiably crowned queen of the climbers. They are very accommodating garden plants. Drama, rhythm, and movement can be created in a garden of any size or shape. Widely known as climbers, the genus also includes shrubby, and herbaceous species and cultivars.

It is the first-ever encyclopedia on the genus and includes more than 550 garden-worthy species and hybrids of the more that 800 listed in the *Royal Horticultural Society's Plant Finder* (1999-2000 ed.). Profusely illustrated, there is an full-color illustration for each of the species and cultivars described located next to the detailed description.

This long-awaited book is separated into two Parts. The first Part is devoted to the care and cultivation of clematis, history and botany, pruning, propagation and hybridization, pests and diseases, and a chapter devoted to growing clematis in North America. The second Part provides an A–Z directory of more than 550 plants, from the acclaimed large-flowered forms to the less familiar shrubby, sub shrubby, and herbaceous forms that are beginning to be available. Using everyday language, the authors provide plant descriptions that include information on synonyms, origin, plant habit and height, flowers, pruning group, flowering period, cultural requirements, recommended uses in the garden, and hardiness zones. Several useful appendices assist gardeners in choosing the right plant for the right site and in obtaining reliable plants and seeds. A list of nurseries is included which specialize in mail order, both foreign and domestic. There is also information included to enable gardeners to choose a clematis by name or by color. The text is accompanied by more than 650

magnificent color photos, making this encyclopedia an indispensable reference and guide. This book is written by gardeners with a passion for these wonderful, colorful plants for gardeners with a passion to grow them. It is recommended for all gardeners and amateur growers, as well as the nursery professional and those libraries serving them.—*Gary L. Jennings, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A.*

MAGNUS JOHNSON. 2001. **The Genus Clematis. Edited and Translated by Bengt Sundström.** (ISBN 91-631-1030-X, hbk.). Magnus Johnson Plantskola AB and Bengt Sundström, Bränningestrandsvägen 63, 151 39 SÖDERTÄLJE, Sweden. (Orders: 08-550 979 77; +468 550 970 77). $110.00, 896 pp, 24 gouaches, about 100 illustrations from classical literature and ink drawings by the author, about 170 color photos, 6 3/4" × 9 1/2".

The Genus Clematis, by Magnus Johnson, is a summary of the knowledge the author acquired during his career as a botanist, landscape architect and nurseryman about clematis. He purpose was to provide a historical review of its use and cultivation in gardens and to present an ordered arrangement of descriptions of the species and cultivars.

There are plants esteemed for their fragrance roses, lilies of the valley, others because they are associated with certain values—bluebonnets of spring, saw tooth maples bursting into color, tall grass prairies reaching to the sun, and still others charged with symbolism—white lilies, red poinsettias and blue forget-me-nots. A clematis has its effect by its immediate beauty. The shape of the flowers, the infinite variation of color, their graceful and elegant foliage. One may experience this through the beauty and structure exhibited in the gouaches and ink drawings of Magnus Johnson's reproduced in this work. He was awarded the Grenfell Medal by the Royal Horticultural Society for his gouaches.

The book is presented in three parts. The first deals with the history, horticultural aspects, and the cultivation and propagation of clematis. The second part is a scientific description of clematis and gives an overview of different characteristics in text and drawings. It also includes a historical review of the genus classification by different scientists cumulating with the author's view. In the third part, each section is introduced by a description of general characteristics, maps showing the distribution of each section, and comments on the use of Clematis in gardening. Each description begins with references to the literature cited, with a complete bibliography following the description section. A total of 325 species are described with around 180 varieties and 1,400 cultivars treated. A basic terminology of particular words used in the text is included, with about 200 words, in English-German-French-Latin and -Swedish listed.

Originally published in 1996 in Sweden, this translation undertaken by Johnson's son-in-law. He has delivered with flair both the charm and intrinsic beauty of the work. Dr. Mary Toomey assisted in turning the translation into readable English and in developing the chapter on history, taxonomy and characteristics.

This book is recommended for serious gardeners, nursery professionals, and botanists and researchers who wish to understand clematis better. Highly recommended for libraries serving this population. It is too early to declare that this is a classic but it bears all the markings of one.—*Gary L. Jennings, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A.*

JAMES F. FRALISH and SCOTT B. FRANKLIN. 2002. **Taxonomy and Ecology of Woody Plants of North American Forests (excluding Mexico and Subtropical Florida).** Illustrations by Hyosun Park. (ISBN 0-471-16158-6, hbk.) John Wiley and Sons Inc. One Wiley Drive, Somerset, NJ 08875, U.S.A. (Orders: 732-469-4400, 732-302-2300 fax). $100.00, 624 pp, 550 line drawings.

Advances and developments in forestry and wildlife management in recent years have been borne out of vast amounts of scientific information and heightened public awareness of the value of our forests. This book seeks to educate its audience about the taxonomy and community ecology of North American forests. It begins with two chapters that appropriately introduce reader to taxonomy and forest ecology. Key ecological terms, such as population vs. community, are clearly defined, a section on forest community ecology and community (cover) types is included, and taxonomic concepts are introduced. Taxonomy seems to be one of the major themes in this book, with more emphasis on the principles of taxonomy and less on simple sight identification of only important commercial trees.

The book is generally divided into four major parts: **I.** Taxonomic Concepts and Methodology, **II.** Gymnosperms (Division Pinophyta), **III.** Woody Angiosperms (Division Magnoliophyta), and **IV.** Forest Community Ecology: Combining Species into Communities. **Part I** begins with the fundamentals of plant classification. Definitions of family, genera, species are provided, as well as explanations of latin binomials and author names. Proper techniques for collecting, labeling and preserving plant specimens are explained. Finally, the authors instruct on how to construct and use taxonomic keys.

In **Part II,** gymnosperms are considered. The section begins with an overview of gymnosperms, which includes, for example, sections on evolutionary history, wood composition and geographic range. The following chapter is a discussion of vegetative and reproductive structures. Subsequent four chapters are comprised of taxonomic descriptions of gymnosperm species in the Pinales, Taxales, Ginkgoales and Cycadales.

Part III deals with woody angiosperms, beginning like part II with an overview of the group. Information is included on life form, morphology and the taxonomic classification that follows Cronquist. There are two chapters on vegetative morphology and one chapter on reproductive morphology. The following eight chapters are dedicated to taxonomic descriptions. As in part II, taxonomic descriptions begin with a short discussion of familial characteristics, the number of taxa and taxonomic affinities. After each family are individual species descriptions with common names, a comprehensive, yet not overly complex discussion of morphological characters, economic importance, geographic distribution and cover types. Cover types can be cross referenced to part IV.

Last, **Part IV** interprets forest community ecology, integrating the gymnosperm and angiosperm species previously discussed into communities. The first chapter in this section explains the different factors that contribute to forest composition. Factors such as climate, soil, topography and geology are considered. Moreover, a discussion of forest classification systems is put forth. To identify communities within natural vegetation regions, the authors employed the National Vegetation Classification Standard developed by the Nature Conservancy and developed their own naming strategy for the various communities described, which closely follows the Society of American Foresters' cover type system. The last five chapters of this book describe different forests in North America. Generally, these include Northern Conifer-Hardwood, Central Hardwood, Southern Pine-Hardwood, Rocky Mountain Conifer, and Northern and Southern Conifer Forests. The book ends with glossaries of technical terms and genus and species names, and separate species and subject indices.

This review would be incomplete without some recognition of the illustrations provided in this book. With 550 line drawings, the majority of the species described herein are illustrated. These

illustrations are informative, expository and beautiful. While they enhance the aesthetics of the book, they also tremendously increase the scientific value by providing a clear identification tool to support each species description. With more than 800 species described, this book is absolutely packed with information on woody plants. The comprehensive nature of this book makes it invaluable and a necessary text for any classes where dendrology, taxonomy, forestry, botany, resource management or environmental studies are taught. Fralish and Franklin have clearly set a high standard for the future of dendrology texts.—*Amy Trauth Nare, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102, U.S.A., amy_trauth@yahoo.com.*

DONALD WATTS. 2000. **Elsevier's Dictionary of Plant Names and their Origin.** (ISBN: 0444503560, hbk.). Elsevier Science B.V., Sara Burgerhartstraat 25, P.O. Box 211, 1000 AE Amsterdam, The Netherlands. $209.50, 1001 pp, 6 1/2" × 9 1/2".

The dictionary contains about 30,000 vernacular and literary names of plants (primarily of English origin, although American, Australian, New Zealand, and South African names are included), both wild and cultivated, with their botanical name and a brief account of the names' meaning if known

Knowledge of plant names can give insight into largely forgotten beliefs. Such names were probably the result of some taboo against picking the plant or eating the fruit. Names may also be purely descriptive, and can also serve to explain the meaning of the botanical name. Literary, or "book" names, have also been included in this dictionary, as being a very important part of the whole. That is, names of plants that were written but never used in the vernacular. Names in many instances provide links to the transmission of words through the ages.

The work represents an extensive accumulation of names from a wide diversity of sources. An entry is presented by the vernacular name followed by its botanical (Latin) synonym. This may be expanded by the addition of a vernacular synonym and the source of the primary epithet. Users must reference the source by referring to the bibliography at the front of the dictionary. There is access to a botanical name when a vernacular name is known but not the converse. There is no index of botanical names. There is not a single main entry for vernacular 'binomials'. Each part has its own complete, and largely duplicated, entry. There are no cross-references, thus Aaron's Beard and Beard, Aaron's share the information. All of the vernacular synonyms have their own individual entries rather than being grouped together under a common botanical name.

The work was conceived as part of the author's wider interest in plant and tree lore, and ethnobotanical studies. A labor of love, a monument to the author, but its bulk, poor editing, out-of-date botanical nomenclature, and price only serve to make this less than an adequate choice for most libraries or researchers. Its restricted geographic scope also weighs against a potential purchase. It is not only British in scope, but heavily biased towards southern Britain. Although many of the names listed are current, most belong in the past, and the author makes no attempt to indicate which are current. This work is recommended only for those very large libraries that must have everything available on the subject.—*Gary L. Jennings, Botanical Research Institute of Texas, Fort Worth, TX 76102-4060, U.S.A.*

DAVID J. SCHMIDLY. 2002. **Texas Natural History: A Century of Change.** (ISBN 0-89672-469-7, hbk.). Texas Tech University Press, P.O. Box 41037, Lubbock, TX 79409-1037, U.S.A. (Orders: 800-832-4042, www.ttup.ttu.edu/). $39.95, 576 pp, 144 b/w figures, 43 maps, notes, 7" × 11".

With the publication of "*Texas Natural history: A Century of Change,*" Dr. Schmidly has done a great service for both professional and amateur naturalists in Texas. The bulk of this volume is a re-publication of Vernon Bailey's "*Biological Survey of Texas.*" The survey was conducted between 1889 and 1905 by Bailey and twelve "federal agents" and was published in 1905. The *Survey* has been out of print since the 1920s, so it has been inaccessible to older naturalists and essentially unknown to younger naturalists. The *Survey* contains a wealth of information that is valuable for the historical perspective it provides as well as forming a basis of comparison with the current status of biological diversity in Texas.

The **first chapter** of this seven-chapter book covers the historical setting and events leading up to the initiation of the biological survey of Texas. Dr. Schmidly provides a detailed account of the people involved, their personalities, and their professional and personal lives. In fact, there is so much information that it may be bewildering for readers who have little knowledge of the important figures in the history of natural history. In spite of the voluminous information in this chapter, some details that would be of considerable interest are lacking. In addition to the people, Dr. Schmidly covers the political situation and the government agencies involved in the effort to document the nation's biological resources. One of the motivations of this effort was agricultural concerns, especially in the western states, so much of the survey was focused on plant communities and mammals, whose economic and agricultural impacts are potentially great. Thus Dr. Schmidly's approach is decidedly, admittedly, and appropriately centered on mammals.

The **second chapter** is the re-publication of the *Biological Survey of Texas*, which covers pages 51–266 of the book. The first 37 pages of the *Survey* describe "faunal areas" or "life zones" of Texas, and outlines their characteristic flora and fauna. This section of the *Survey* contains much valuable information for those interested in the vegetation zones of the state and their associated vertebrate fauna. The next several pages cover lizards and snakes, although amphibians are unfortunately completely omitted. The remainder of the *Survey* is a detailed account of the biology, distribution, and conservation status of 181 taxa of mammals. By any standard, this is an impressive contribution to scientific knowledge, and in this case the information was obtained under conditions that were primitive at best. Forty-nine new taxa of mammals were described through the efforts of the survey team, nine of which were first described in the *Survey* itself. As Dr. Schmidly points out, all but nine of these species are currently recognized as valid, which is testament to the scientific ability of the federal agents. Obviously the mammal section of the *Survey* contains much information of historical value, such as reports of large carnivores and ungulates, but it also contains information that elucidates changes in distribution and abundance of rodents, bats, "varmints," and other species of current biological interest.

In **chapter 3,** "Annotations of the *Biological Survey of Texas*" Dr. Schmidly updates the information presented in the *Survey*, and includes changes in taxonomy, nomenclature, distribution, and abundance, as well as comments on conservation status. The information comes from the scientific literature and the author's decades of experience with Texas mammals. This chapter will be of considerable use to professional mammalogists in comparing the information in the survey with current knowledge, and in interpreting changes in patterns of distribution and abundance. For the informed amateur or the professional field biologist who specializes in an area other than mammalogy, Chapter 3 gives a look at the give and take through which taxonomy and systematics proceeds, and

at changes in the fauna as well as changes in the scientific study of the fauna. We also occasionally get a glimpse into the past that highlights the professional activities of predecessors or old friends.

Chapter 4, "Texas Landscapes, 1889–1905" gives Bailey and the federal agents the opportunity to tell us what they saw in their own words, and through their photographs show us the Texas landscapes they saw. This chapter will fascinate anyone interested in biogeography and the biotic districts of Texas. The many photographs and first-hand descriptions reveal landscapes that were in many instances already heavily transformed by human activity. According to Dr. Schmidly, "Of all the community types...the greatest adverse impacts appear to have been on grasslands." In fact, the blackland prairies of north central Texas are barely mentioned in the survey. This should not be surprising because the blacklands are among the most fertile areas of the country, and had been converted to croplands long before the years of the biological survey. In reading the accounts and seeing the photographs, it appears that some Texas landscapes were more heavily transformed in the late 1800s than they are today. This realization gives hope that remnants of each of the "life zones" of Texas may be preserved. Unfortunately, other information in this chapter makes it clear that there is little hope that Texas biological communities can be restored to a state even vaguely similar to their condition before settlement by Europeans.

Chapter 5, "Twentieth Century Changes in Texas Landscapes and Land Uses" continues the development of the idea that although the 20th century was one of dramatic change in Texas biota, the reader should not assume that there had been no changes prior to the years of the survey. In fact, one of the most important points of this work is that much of the Texas landscape had been altered substantially before the survey was conducted. Another important point is that not all of the changes that have occurred since the survey were for the worse. Many changes in the 20th century have come about through conservation and restoration efforts by government agencies, private organizations, and concerned landowners.

Chapter 6 on "Twentieth Century Changes in the Texas Mammal Fauna" will probably prove to be the most useful to professional mammalogists. This chapter discusses several categories of changes that have occurred, including local (e.g. within Texas) extinctions, dramatic declines in abundance, changes in distributions, and discovery of new taxa.

Sections on the introduction of exotic ungulates for show and hunting (the "texotics") and on the historical development of mammalogy in Texas will interest the amateur naturalist. The section on "Introduction of nonindigenous species" appears to take Dr. Schmidly pretty far afield; why not just say "exotic" rather than "nonindigenous"? The discussions of the red imported fire ant and the brown tree snake barely scratch the surface of the literature on these exotic species and their effects on endemic biota

Finally, in **chapter 7,** Dr. Schmidly discusses "Challenges for Wildlife Conservation in Texas." This chapter is insightful in some places but frustratingly vague and incomplete in other places. In the first pages the discussion leaves unanswered or glosses over some potentially substantial areas of controversy, for instance the multiple (and conflicting) uses of the term "sustainable" and how sustainability figures into conservation strategies. The chapter discusses "new perspectives in conservation," many of which are strategies that have been discussed in conservation circles for years. The focus in the latter part of the chapter seems to be on "managing wildlife diversity," although what type of wildlife needs to be managed is not made clear. The emphasis seems to be on large mammals and other game animals, but this is not specified. The discussion of "challenges to managing wildlife diversity" presents a series of strategies for promoting conservation of biological diversity which have appeared in the conservation literature in the recent past

It is impossible to produce a book of this scope without errors creeping in, and this work is no exception. Some errors are a result of inattentive editing, such as typographical errors (some of which are quite noticeable), but others are a result of careless editing, such as a typesetting error on page 47

and captions for figures that don't match the figures. Many of the black and white photos reproduced in the book provide a valuable perspective, but there are several that are of such poor quality that they detract from the presentation more than they add. In some sections is seems that Dr. Schmidly is unsure whether his audience is professional biologists or informed amateurs. Professionals would like to see more precise use of scientific vocabulary (e.g. variation, communities, adaptation) and more documentation from the primary literature, where amateurs would prefer clear and concise descriptions of events and processes without technical jargon.

In spite of these minor criticisms, this book is a substantive contribution to our knowledge and understanding of Texas natural history, and provides a perspective on changes in the biota of Texas with applicability far beyond its borders. Because "east meets west and north meets south" in Texas, many of the changes that occurred and the processes that caused them will have occurred in other places, and the understanding of the changes and processes that this book provides will inform scientists working in those areas. Dr. Schmidly has indeed done a great service for professional naturalists in Texas and elsewhere.—*Steven Goldsmith, Department of Biology, Austin College, Sherman, TX 75090, U.S.A. sgoldsmith@austincollege.edu.*

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THE RESURRECTION AND LECTOTYPIFICATION OF *TETRAZYGIA FADYENII* (MELASTOMATACEAE: MICONIEAE): A HUMMINGBIRD-POLLINATED TREELET ENDEMIC TO JAMAICA

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ABSTRACT

In the course of a cladistic analysis and systematic revision of *Charianthus* (Melastomataceae: Miconieae), it was discovered that one species, *C. fadyenii* (Hook.) Griseb., is unrelated to the other members of that genus, and this species is thus reassigned to *Tetrazygia*

RESUMEN

En el curso de un análisis cladístico y revisión sistemática de *Charianthus* (Melastomataceae: Miconieae), se descubrió que una especie, *C. fadyenii* (Hook.) Griseb., no está relacionada a los otros miembros de este género y por ello es reasignado a *Tetrazygia*.

INTRODUCTION

Tetrazygia fadyenii is a very attractive melastome endemic to the Greater Antillean island of Jamaica. This species was first described by W. J. Hooker (1849) as *Tetrazygia fadyenii*. A. H. R. Grisebach (1864), misled by superficial morphological adaptations common to hummingbird-pollinated plants, transferred the species to *Charianthus* Don. The incorrect placement of this species (as *C. fadyenii* (Hook.) Griseb.) persisted through subsequent classifications and floristic treatments by Triana (1871), Cogniaux (1891), Hodge (1941), Adams (1972), and Howard (1989). Judd and Skean (1991) recognized the non-monophyletic circumscription of *Charianthus*, and transferred this species to *Miconia* sect. *Miconia*. Convergent evolution, likely driven by parallel shifts to bird pollination in *Charianthus* and *Tetrazygia fadyenii*, has resulted in the presence of relatively large, red, pseudocampanulate corollas and nectar production in both taxa. We note that J. Dan Skean, Jr. has observed hummingbirds visiting flowers of *T. fadyenii* (pers. comm.; *Skean & Samuels 1840*).

In the course of cladistic analyses of *Charianthus* based on both morphology and nuclear ribosomal ITS sequences (Penneys 2001, in prep.), it was discovered that numerous morphological and molecular synapomorphies unite

the six species of that clade. As newly circumscribed (Penneys 2001), *Charianthus* is the only plant genus endemic to the Lesser Antilles.

Additionally, *Tetrazygia fadyenii* was found to form a clade with *T. bicolor* and *T. crotonifolia* (and presumably, other species of *Tetrazygia*). Although *T. fadyenii* is currently best placed within *Tetrazygia*, ongoing investigations by the authors (and collaborators) on the phylogenetics of the Miconieae are needed to confirm this placement. The monophyly of *Tetrazygia* is supported in our preliminary analyses, but additional investigations, using more species, are needed. The monophyly of *Miconia* is doubtful, and recognition of other genera within the tribe may make *Miconia* paraphyletic, but this matter is beyond the scope of this paper.

Some morphological characters distinguishing *Tetrazygia fadyenii* from *Charianthus* and uniting it with *T. bicolor* include: the presence of druse crystals (vs. these lacking), anthers opening by terminal pores (vs. slits), a 2-loculate (vs. 4-loculate) ovary, presence of mite domatia (vs. such structures lacking), spatulate (vs. broadly ovate) petals, the calyx constricted above the ovary (vs. not constricted), an adaxial thickening of the anther base (vs. anther base non-thickened), and rounded branches (vs. flat branches) of the stellate hairs. The presence of a hypanthium strongly constricted in fruit above the ovary may be a synapomorphy for *Tetrazygia*, and is clearly evident in *T. fadyenii*. Thus, this distinctive species should again be known by its basionym, *T. fadyenii*. Its resemblance to *Charianthus* is superficial. As outlined above, these similarities presumably reflect convergent adaptations to bird pollination.

It is also of interest that the species of *Tetrazygia* occur chiefly over limestone, as does *T. fadyenii*, while the species of *Charianthus* sensu stricto grow on volcanic substrates.

Jamaica is home to four species of *Tetrazygia*, of which three are considered to be endemic (Adams 1972). This pattern of endemism is the norm for *Tetrazygia* throughout its range; the majority of species in the genus are single-island endemics. *Tetrazygia fadyenii* can be distinguished from other Jamaican members of the genus by the combination of elliptic (rarely widely elliptic or narrow obovate), essentially glabrous leaves, and bright red petals that are 9.5 to 13.5 mm long.

TAXONOMIC TREATMENT OF *TETRAZYGIA FADYENII*

Tetrazygia fadyenii Hook., Hooker's J. Bot. Kew Gard. Misc. 1:379, t. 12. 1849.

Charianthus fadyenii (Hook.) Grisebach, Fl. Br. W. Ind. Isl. 264. 1864. *Miconia fadyenii* (Hook.) W. Judd & Skean, Bull. Florida Mus. Nat. Hist. 36(2):25–84. 1991. LECTOTYPE, designated here: "*Melastoma*. Hab – [illegible] District St. Anns [sic]. This is the most beautiful plant I have seen in Jamaica. Seeds 227." Macfadyen (K, H2001/02842-1, fragment A!). ISOLECTOYPES, designated here: "Jamaica. Dr. McFadyen *Tetrazygia fadyenii*." (K, H2001/02842-2, fragment D!); "*Tetrazygia? fadyenii* Hook. Kew Journ. 1849. Jamaica. Macfadyen. Hooker 1849." (K, H2001/02842-3, fragment G!).

Nomenclatural note.—Three sheets located at K must be considered in the lectotypification of *Tetrazygia fadyenii* Hook. Each of the three sheets contain three twigs, which have been designated with consecutive letters for clarity, thus, sheet H2001/02842-1 has fragments labeled A through C, H2001/02842-2 with fragments D through F, and H2001/02842-3 with fragments G through I. All specimens designated here as lectotype material were seen by Hooker in 1849, or earlier, and were collected by MacFadyen. Proof of this is demonstrated either by their label data or by representation in the illustration of the species published by Hooker in 1849.

The BM collection H2001/02842-1 has attached to it the illustration that accompanied Hooker's description of the new species (Hooker's J. Bot. Kew Gard. Misc. 1:379, t. 12. 1849.). In that description, Hooker noted that MacFadyen provided him with specimens of the species, which he then named in his honor. This sheet also has a label, presumably written in the field by MacFadyen, that reads, "*Melastoma* sp. Hab – [illegible] District St. Anns [sic]. This is the most beautiful plant I have seen in Jamaica. Seeds 227." Written in a different hand at the top of that label is "*Charianthus* sp. nov." Fragment A, a leafy twig in fruiting condition, is here selected as the lectotype of *Tetrazygia fadyenii* Hook. This collection is from the Hooker herbarium, and was annotated by Hooker as *T. fadyenii* Hook. A fruit and seed of fragment A are represented as figures six and seven in the abovementioned illustration. Fragment B is in bud and flower, but cannot be definitively considered to have been seen by Hooker. Fragment C is a poor, sterile specimen.

Label data are completely lacking on H2001/02842-2. However, fragment D, at least, was observed by Hooker, who wrote next to that flowering twig, "Jamaica. Dr. McFadyen *Tetrazygia fadyenii*." This fragment was likely used for the habit (figure unnumbered) and flower figures two and three of the illustration cited above, which it very closely resembles, and we consider it to be an isolectotype. Fragment E is a smaller flowering twig, and F is nothing more than a scrap with five mature fruits and the date 1850. The sheet is annotated in an unidentified hand as *Charianthus fadyenii* Griseb.

From the sheet H2001/02842-3, it may be presumed that Hooker sent material of *Tetrazygia fadyenii* to Bentham as this sheet has "Herbarium Benthamianum 1854" stamps next to fragments G and I. Fragment G is a small flowering specimen overlaid by a label stating: "*Tetrazygia? Fadyenii* Hook. Kew Journ. 1849. Jamaica Macfadyen. Hooker 1849." It, therefore, appears that this fragment was included with the material originally under consideration by Hooker when he described the species. We consider it to be a possible additional isolectotype. The fruiting (and sparsely budding) twig H cannot definitively be assigned to either of the other two samples of this sheet. Fragment I is a budding twig with a label glued over it on which it is written, "Jamaica. Hooker 1843." The collec-

tor of fragment I is unknown. This sheet is annotated below as "*Charianthus fadyenii* Griseb. Triana in Linn. Trans. Vol. 28, p. 99."

Description.—Evergreen shrubs or small trees to 10 m high. Druse crystals present. Bark smooth to shallowly, longitudinally fissured; young twigs terete (slightly quadrangular), gray-brown, essentially glabrous but with a very sparse indumentum of inconspicuous, stellate and unicellular, uniseriate hairs, the stellate hairs ca. 0.09–0.13 mm in diameter, nodes (1.93–)2.13–3(–5) mm in diameter, a slightly expanded, inconspicuous interpetiolar ridge present, with inconspicuous stellate pubescence, the hairs (0.05–)0.08–0.19(–0.21) mm in diameter. Leaf blade coriaceous, elliptic (widely elliptic or narrow obovate), (3.2) 4.4–6.5(–8) cm long, (1.8–)2.2–3.1(–3.5) cm wide, blades somewhat V-shaped, margins flat (very slightly revolute), light green, yellowish-green below, with midrib, secondary veins, and margins sometimes reddish; apex acute (barely obtuse), base acute, acute cuneate or cuneate (obtuse); adaxial surface of young blades with sparse stellate hairs (some sunken in pits) and unicellular hairs, the stellate hairs (0.05–)0.08–0.19 mm in diameter, mature leaves glabrous with extremely sparse stellate and unicellular hairs, abaxial surface of young blades with few unicellular or multicellular uniseriate hairs, sometimes with very dense stellate hairs (0.05–)0.08–0.19(–0.24) mm in diameter, mature leaves appearing glabrous but with few stellate hairs, often sunken in pits and appearing as punctations (0.05–)0.08–0.24(–0.25) mm in diameter; domatia (occasionally absent) of primary-axillary hair tufts, the domatial hairs multicellular multiseriate dendritic setae, domatia (0.48–)0.56–2.34(–2.80) mm long, (0.32–) 0.33–1.47(–2.54) mm wide; margin entire; venation suprabasal (basal) with (1–) 2 pairs of secondary veins, and 1 pair of inconspicuous submarginal secondary veins, the tertiary veins very indistinct (10–)12–19(–21), intergrading with quaternary veins at base and apex; midrib and secondary veins flat to slightly impressed adaxially, tertiary and quaternary veins very indistinct adaxially, midrib raised abaxially, secondary veins slightly raised to flat abaxially, tertiary and quaternary veins flat abaxially. Petiole (0.51–)0.60–1.35(–1.80) cm long, shallowly canaliculate, often reddish, moderately stellate pubescent, with the hairs ± evenly distributed on all parts of petiole or somewhat denser abaxially, these (0.06–)0.08–0.19(–0.25) mm in diameter. Inflorescence terminal, cymose, paniculate (loosely corymbose), (3.6–)5.7–8.8(9.5) cm long, (3.4–)3.5–5.4(–5.5) cm wide, with 2–3 orders of branching, the caducous bracts to ca 3 cm long; peduncle (1.9–)2.2–2.9(–3.6) cm long, first internode above peduncle (1.03–)1.30–1.80(–2.20) cm long, first lateral internode (1–)1.1–1.7(–2.2) cm long, the flowers (21–)27–43(–76) per inflorescence. Pedicels (4.75–)5.25–7.75(–10.50) mm long, with stellate hairs (0.09–)0.11–0.16(–0.18) mm in diameter. Hypanthium cylindrical to suborbicular around ovary, tubular above ovary, (2.69–)2.75–3.60(–3.63) mm long as measured from base of hypanthium to torus, (2.07–)2.16–3.14(–3.47) mm wide, indumentum of stellate hairs, (0.05–)0.06–0.11(–0.18) mm in diam-

eter, the portion of hypanthium free from ovary (0.97–)1.11–1.38(–1.57) mm long; inner hypanthium smooth (inconspicuously ridged), torus to calyx apex length (1.72–)2.50–3.54(–3.73) mm, torus to calyx notch length (1.63–)2.19–3.27(–3.32) mm. Calyx lobes 4, (0.09–)0.16–0.53(–0.69) mm long, (2.13–)2.32–2.97(–3.13) mm wide, lobes very broadly triangular (often to such a degree that the lobes are difficult to discern), the indumentum similar to that of hypanthium, the external calyx teeth (0.25–)0.33–0.63(–0.67) mm long, usually only a blunt knob on rim of hypanthium. Petals 4, bright red, oblong spatulate, the apex truncate, (9.50–)9.88–13.13(–13.63) mm long, (3–)3.13–4(–4.31) mm wide, glabrous, many-veined, erect or slightly spreading. Stamens 8, folded adaxially in bud, in two series, isomorphic, (19–)20–21.5(–22) mm long; filaments pink, slightly tapered towards apex, 14.5–16 mm long, with proximal filament segment (0.38–)0.41–0.60(–0.67) mm wide, distal segment (0.22–)0.28–0.50(–0.53) mm wide; anthers yellow, (4.46–)4.94–5.94(–6.07) mm long, (0.53–)0.60–0.81(–0.82) mm wide, elliptic, slightly curving, opening by a single apical pore (0.19–)0.27–0.37(–0.45) mm wide. Ovary inferior, 2-loculate, (1.94–)1.97–2.94(–3) mm long, (1–)1.13–1.41(–1.87) mm wide, with an apical appendage (0.94–)0.97–1.22(–1.25) mm long, with deeply intruded axile placentation; style pink or red, straight to shallowly S-shaped, glabrous, (20.5–)21–24(–24.2) mm long, (0.38–)0.41–0.57(–0.60) mm wide; stigma not expanded, papillose. Berries globose-urceolate, 4–7 mm in diameter, urceolate, deep purple. Seeds pyramidal, 1.35–1.50 mm long, 0.75–1.03 mm wide, the testa smooth. See Figure 1 (see also Hodge 1941, *plate 6, figures 5 and 6*).

Distribution and ecology.—*Tetrazygia fadyenii* is endemic to Jamaica. It occurs on limestone hills in xeric to mesic woodlands and forest edges from 450 to 950 meters elev. where it may be locally common (Fig. 2).

Phenology.—*Tetrazygia fadyenii* has been collected in reproductive condition throughout the year, with the exception of the month of November.

Specimens examined: **JAMAICA. Clarendon:** 1.5 mi SSW of junction at Cave Valley, 17 Jul 1977, *Goodfriend* (FLAS); Peckham Woods, Upper Clarendon, 7 Jul 1911, *Harris 10997* (NY, US); Peckham Woods, Upper Clarendon, 27 Sep 1912, *Harris 11181* (NY, US); Bird Cave Rock, Glenwood Springs, Balcarres, Sunbury Road, 4 Jan 1974, *Morley & Whiteford 967* (A); Glenwood Springs district, between Balcarres and Sunbury, 18 Aug 1973, *Proctor 33485* (IJ). **Hanover:** Dolphin Head, 18 May 1906, *Harris 9234* (A, US); Dolphin Head, SW of Askenish, ca. 7 mi S of Lucea, 12 May 1987, *Judd & Samuels 5300* (FLAS, NY); 12 May 1987, *Judd & Samuels 5311* (FLAS, NY); near Askenish, Dolphin Head, 29 Jun 1975, *Judd, Kress & Clarkson 75-141* (A); summit of Dolphin Head, 29 Oct 1952, *Proctor 7275* (IJ, US); Dolphin Head, on the top, 9 Jul 1986, *Skean & Samuels 1840* (NY, US); Dolphin Head Mountain, 8 mi SSE by road from Lucea, 1 Aug 1967, *Weaver 1278* (GH, MO); Dolphin Head, 28 Jul 1954, *Webster & Wilson 5071* (A, US); slopes of Dolphin Head, 24 Jun 1959, *Webster et al. 8563* (S). **Manchester:** at Banana Ground, 14 Jul 1963, *Crosby, Hespenheide & Anderson 673* (GH, NY); 0.5 mis NW of Christiana, 3 Jul 1955, *Howard & Proctor 14331* (A); between Fairfield and Huntley, 9 Jan 1957, *Proctor 16106* (GH); Gourie Forest, ca. 1 mi SW of Coleyville, 18 Apr 1971, *Proctor 31748* (IJ); Huntley Hill, 20 Jul 1978, *Proctor 37906* (MO). **Middlesex:** St. Anne. Mt. Diablo, 22 Jan 1938, *Hunnewell 15322* (GH). **St. Ann:** Albion, 14 Mar 1850, *Grisebach s.n.* (GOET); Holly Mount, near Ewarton, 11 Aug 1896, *Harris 6572*

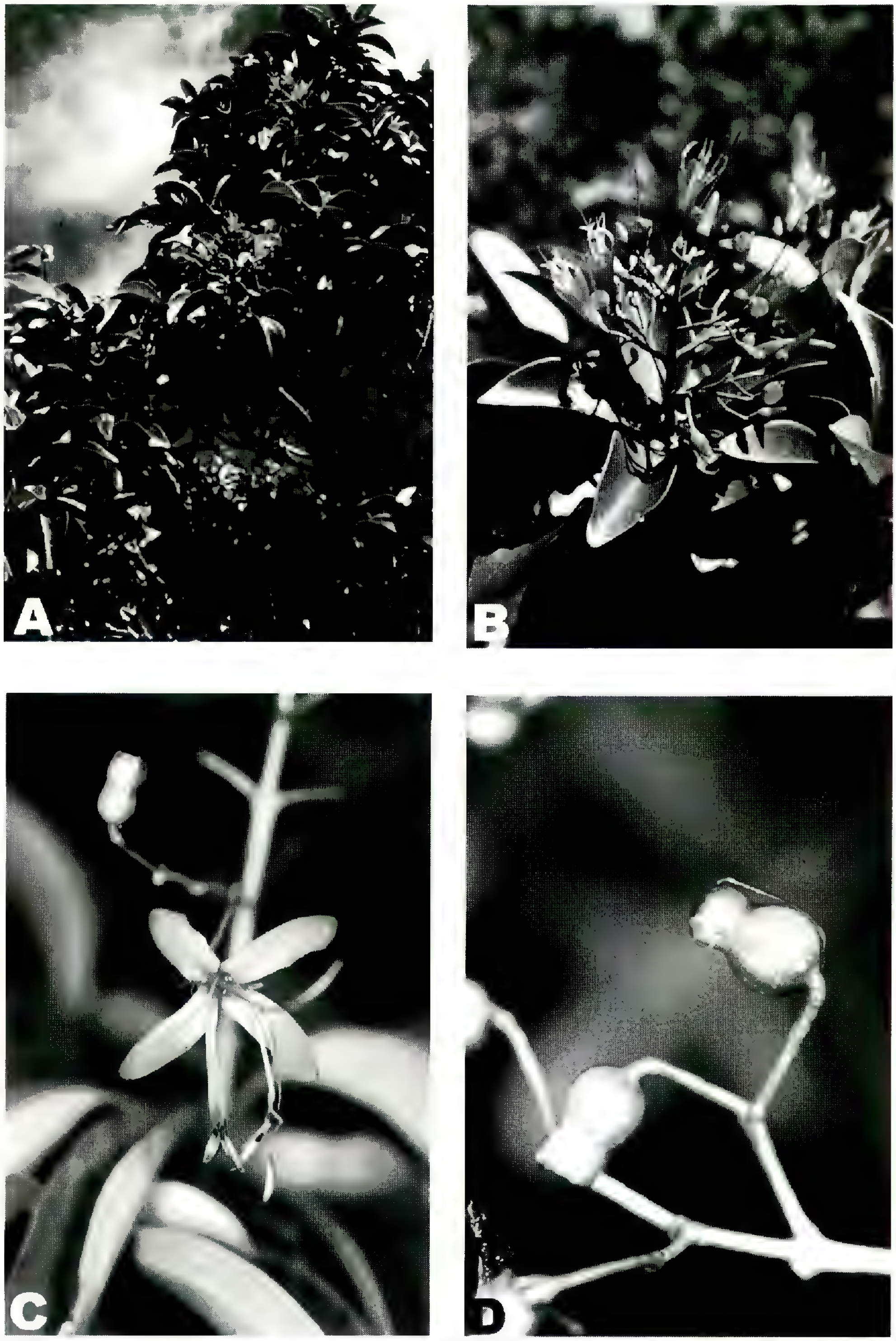


FIG. 1. *Tetrazygia fadyenii*. **A.** Habit. **B.** Inflorescences. **C.** Flower. **D.** Fruits.

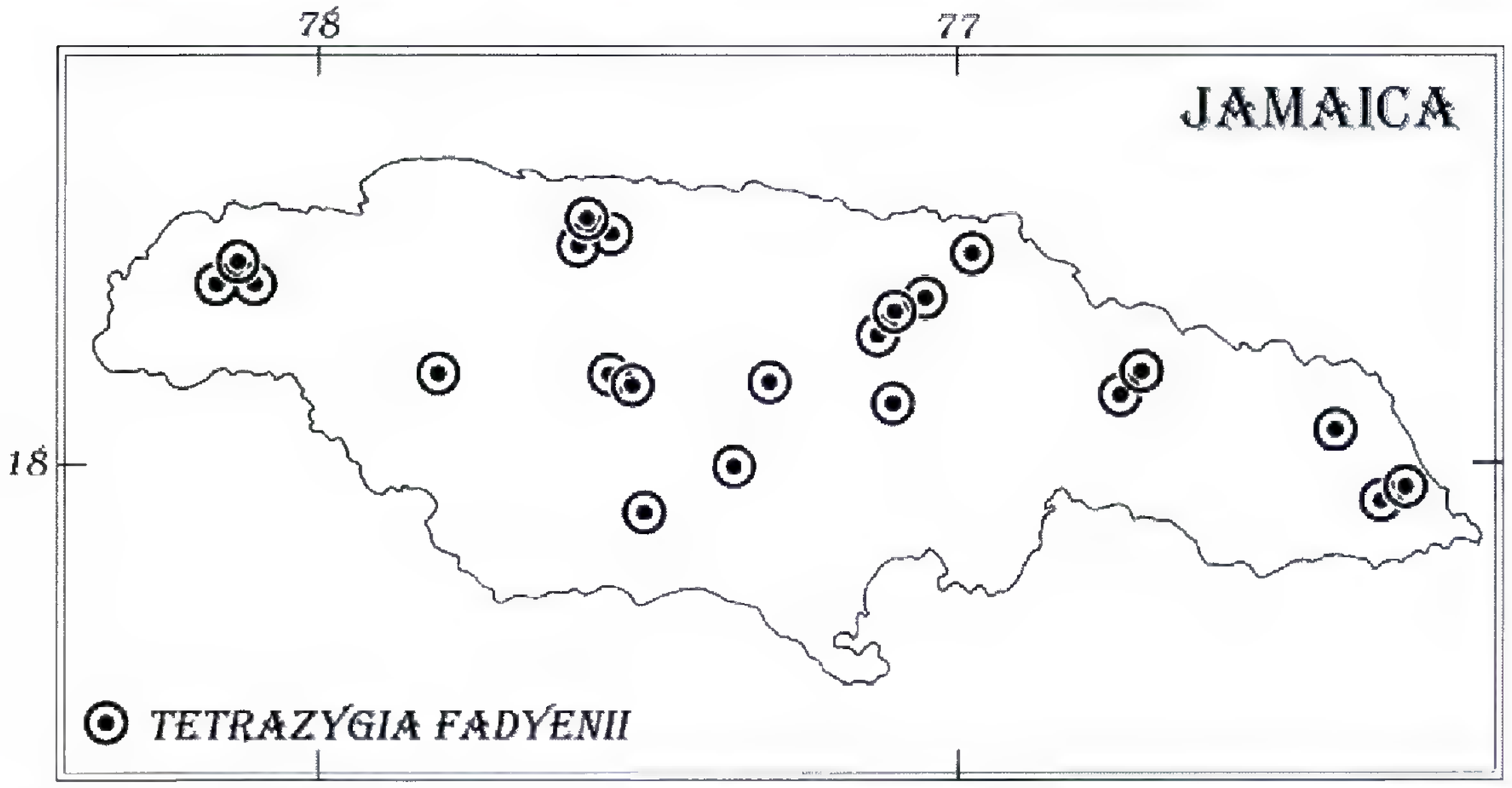


Fig. 2. Distribution of *Tetrazygia fadyenii*.

(NY); Holly Mount, Mt. Diablo, 29 Aug 1905, *Harris 8994* (NY); Mt. Diablo area; ca. 1 mi along road towards Resource, 11 Aug 1965, *Hespenheide 973* (FLAS, GH, MO, NY, US); Mt. Diablo, 27 Jan 1952, *Hunnewell 19761* (A); Mt. Diablo region, lower slopes of Hollymount, 28 May 1987, *Judd 5509* (FLAS, NY); Mt. Diablo, Jul 1849, *McNab s.n.* (US); vicinity of Mosely Hall Cave. 1 mi W of Blackstonedge, 14 Dec 1952, *Proctor 7483* (IJ); Mt. Diablo, Grier Mount, 29 Aug 1954, *Webster & Proctor 5640* (A, US); Mt. Diablo, E slopes above Schwallenburgh, 25 Jun 1959, *Webster et al. 8530* (S). **St. Catherine:** Hollymount, 22 Sep 1962, *Adams 11725* (MO); near summit of Hollymount, 5 Jul 1966, *Anderson & Sternberg 3048* (US); Grier Mount, Mt. Diablo, 20–31 Dec 1953, *Howard & Proctor 13601* (A, IJ); Grier Mount, Mt. Diablo, 20–31 Dec 1953, *Howard & Proctor 13617* (A) **St. Elizabeth:** Mulgrave, 14 Jun 1916, *Harris 12373* (MO, NY, P). **St. Mary:** forests at Union Hill near Moneaque, 13 Jul 1950, *Howard 12019* (A, NY). **St. Thomas:** Big Level District, SE end of John Crow Mts., 16 Mar 1956, *Stearn 508* (A); between Rowlandsfield and Big Level; John Crow Mts., 15 Jun 1976, *Thorne & Proctor 48305* (NY); John Crow Mts., Big Level, above Rowlandsfield, 16 Jun 1959, *Webster et al. 8281* (GH, IJ, S, US). **Trelawny:** between Burnt Hill and Ramgoat Cave, 20 Jul 1997, *Acevedo-Rdgz. 9558* (US); the Cockpit Country, near Barbecue Bottom, 14 Aug 1963, *Crosby & Anderson 1212* (GH); 2–3 mi N by road of Burnt Hill crossroads, 16 Aug 1965, *Hespenheide 1267* (FLAS, MO, NY); at Ramgoat Cave on road from St. Vincents to Kimloss, 26 Sep 1954, *Howard 14130* (A); along road to Mango Tree Hill from Burnt Hill, 27 May 1967, *Read 1937* (GH, US). **Location unknown:** Apr 1903, *Alexander s.n.* (GH, NY); *Grisebach s.n.* (GOET); 15 Feb 1905, *Harris 8883* (NY); 27 Sep 1912, *Harris 11190* (NY, US).

Illustrations of this species can be found in Hooker (1849) and Fawcett and Rendle (1910–1936). Hodge (1941) provided photos of flowers and fruits in plate six, figures five and six.

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MO, NY, P, S, US. The authors are especially grateful to the staff of Kew for furnishing taxonomically critical specimens from their type collection.

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NOMENCLATURAL ADJUSTMENTS AND COMMENTS IN *ABRONIA* AND *ACLEISANTHES* (NYCTAGINACEAE)

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ABSTRACT

A new combination is made for A Flora of the Chihuahuan Desert Region and for Flora of North America North of Mexico in the now more broadly constructed *Acleisanthes* (Nyctaginaceae): **Acleisanthes lanceolata** (Wooton) R.A. Levin var. **megaphylla** (Fowler & B.L. Turner) Spellenb. & J. Poole, comb. nov. This is based on evidence published recently by Levin (2000) showing that neither *Acleisanthes* nor *Selinocarpus* as traditionally treated is monophyletic, but together they form a well-defined clade in the Nyctaginaceae. We also provide a short review of the literature showing that *Commicarpus somalensis* (Chiov.) Lebrun & Stork is correctly an *Acleisanthes* (sensu lato), based on *Selinocarpus somalensis* Chiov. Due to need for consistency in level of infraspecific rank in treatments in Flora of North America North of Mexico *Abronia umbellata* Lam. subsp. *breviflora* (Standl.) Munz is recombined as **Abronia umbellata** Lam. var. **breviflora** (Standl.) L.A. Galloway, comb. et stat. nov.

RESUMEN

Se hace una combinación nueva para "A Flora of the Chihuahuan Desert Region" y para "Flora of North America North of Mexico" en el género *Acleisanthes*, ahora construido mas ampliamente: ***Acleisanthes lanceolata*** (Wooton) R.A. Levin var. ***megaphylla*** (Fowler & B.L. Turner) Spellenb. & J. Poole, comb. nov. Esta combinación resulta de la evidencia recientemente publicada por Levin (2000), demostrando que ni *Acleisanthes* ni *Selinocarpus*, como se han tratado tradicionalmente, son monofiléticos, pero juntos forman un clado bien definido en las Nyctaginaceae. También, ofrecemos citaciones bibliográficas declarando que *Commicarpus somalensis* (Chiov.) Lebrun & Stork es actualmente una *Acleisanthes* (sensu lato), basado en *Selinocarpus somalensis* Chiov. A causa de la necesidad de consistencia a nivel de categorías infraspecíficas en los tratamientos de "Flora of North America North of Mexico" *Abronia umbellata* Lam. subsp. *breviflora* (Standl.) Munz se ha recombinado como ***Abronia umbellata*** Lam. var. ***breviflora*** (Standl.) L.A. Galloway, comb. et stat. nov.

INTRODUCTION

The most recent taxonomic revisions of *Acleisanthes*, *Ammocodon*, and *Selinocarpus* have maintained the genera as distinct (Fowler & Turner 1977; Smith 1976). *Acleisanthes* (7 spp.) and *Selinocarpus* (9 spp.) have been considered distinct genera since their inception; *Ammocodon* (1 sp.) was originally described as a *Selinocarpus* (Torrey 1859). All are from arid or semi-arid regions in southwestern United States and northern Mexico, mostly on the Chihuahuan Desert or adjacent semi-arid closely allied floristic areas, except for *S. somalensis* Chiov., which occurs in northeastern Africa.

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Recently Levin (2000), through the use of nuclear and chloroplast genes, demonstrated that *Acleisanthes* and *Selinocarpus* formed a well defined clade within the Nyctaginaceae, but individually the genera were not monophyletic. Levin (2002) then transferred those species traditionally recognized as *Selinocarpus* and *Ammocodon*, and which she recognized as valid taxa, to *Acleisanthes*. Levin did not recognize varieties in her study, considering them insignificant for her work (pers. comm. to J. Henrickson, 2002). Although the winged fruits of *Selinocarpus* and *Ammocodon* are conspicuous in their differences from the round-ribbed fruits of *Acleisanthes*, it might be inferred from Willson and Spellenberg (1977) that a change from ribbed to winged fruit is not difficult. As discussed by Levin and others, most *Acleisanthes* are herbaceous, whereas many *Selinocarpus* are suffrutescent or woody. *Ammocodon* is herbaceous. All genera produce cleistogamous flowers. In addition, *Selinocarpus diffusus* is very difficult to distinguish from *A. wrightii* vegetatively.

NOMENCLATURE

For an upcoming volume of Flora of North America North of Mexico and for A Flora of the Chihuahuan Desert Region, we are adopting Levin's interpretation of this portion of the Nyctaginaceae, recognizing those taxa traditionally called *Ammocodon* or *Selinocarpus* as *Acleisanthes*. Turner (in Turner et al. 2003) has also adopted an expanded concept of *Acleisanthes* and has made some nomenclatural transfers there. Levin (2002) made only species level nomenclatural transfers. An easily missed error occurred in her work when specific epithets were transferred in the masculine from *Selinocarpus* [masculine] to *Acleisanthes* [feminine]. Corrections necessary are considered orthographic and will be made in upcoming treatments.

Acleisanthes lanceolata (Wooton) R.A. Levin var. **megaphylla** (Fowler & B.L. Turner) Spellenb. & J. Poole, comb. nov. BASIONYM: *Selinocarpus lanceolatus* Wooton var. *megaphyllus* Fowler & B.L. Turner, Phytologia 37:181. 1977. TYPE: MEXICO. CHIHUAHUA: Jurassic gypsum ca. 15 mi SW of Estacion Moreon on Rio Conchos Lake Road, Sierra de la Monillas, 25 May 1971, *Powell 2105* (HOLOTYPE: LL; ISOTYPE: TEX!).

Acleisanthes megaphylla (Fowler & B.L. Turner) B.L. Turner in B.L. Turner et al., Atlas Vasc. Pl. Texas 7. 2003. *Selinocarpus megaphyllus* (Fowler & B.L. Turner) B.L. Turner. Phytologia 75:242. 1993.

The *Acleisanthes lanceolata* complex consists of obligate gypsophiles distributed in islandlike populations from northern New Mexico through western Texas to east-central Chihuahua. There is an irregular cline of increasing leaf width and less noticeably, perianth size, from north to south, with a more or less abrupt difference evident in populations south of the Mexico–U.S. border. *Acleisanthes lanceolata* var. *lanceolata* has lanceolate to broadly lanceolate leaves (larger leaves 5–18 mm wide), whereas *A. lanceolata* var. *megaphylla* has

ovate to round leaves (larger leaves 12–41 mm wide). In the var. *megaphylla* proportionately broadest leaves occur especially on the basal half of the stem. It is this variation that Fowler and Turner were attempting to circumscribe nomenclaturally when they described the new variety, *Selinocarpus lanceolatus* var. *megaphyllus*. Turner went even further in 1993, elevating the var. *megaphyllus* to species level as *S. megaphyllus* (Fowler & B.L. Turner) B.L. Turner and later (2003) as *Acleisanthes megaphylla* (Fowler & B.L. Turner) B.L. Turner in B.L. Turner et al. He formally recognized intermediate populations in western Texas and eastern Chihuahua as *S. maloneanus* B.L. Turner, reducing it to varietal status again in 2003 as *Acleisanthes lanceolata* var. *maloneana* (B.L. Turner) B.L. Turner. Levin (2002) lists all names in the complex that were available at the time as synonyms of *A. lanceolata*.

For A Flora of the Chihuahua Desert Region we will recognize the extremes of variation in the *Acleisanthes lanceolata* complex, which more or less correlate with geography, as two varieties in A. *lanceolata*, the var. *lanceolata* (which includes *A. lanceolata* var. *maloneana*) and var. *megaphylla*. One collection from the southern part of the range of *A. lanceolata* supports the view that these taxa better represent varieties than species. Within a single population are round-leaved plants, intermediates, and lanceolate-leaved plants, the last uncommon in the population (Mexico, Chihuahua, Mcpio. Camargo, 13.6 km W of Camargo on road to Lago Boquilla, on gypsum river terraces, 14 Aug 1974, *Spellenberg and Syvertsen 3758*, CIIDIR, IEB, MEXU, NMC [sheets 46553, 62814], TEX. So that future confusion might be avoided, two replicates of the same collection (3758) were independently prepared and accessioned at NMC several years apart, the first with the label stating distance of the site from Camargo as 8.5 miles rather than 13.6 km, the second stating the distance in kilometers).

Jim Henrickson relates to us in his review of this manuscript that the stated type locality of *Selinocarpus lanceolatus* var. *megaphyllus* is problematic. He states that Estacion Moreon is correctly Estacion Morrión. There is no Sierra de Monillas, but there is the Sierra Morrión (misspelled on Henrickson's gazetteer map [Henrickson & Straw 1976] as Sierra Gorrion). He writes in his review, "But there is a lake behind Presa Luis. L. León along the Río Conchos and there is a road to the south end of the lake about 15 mi SW of Est. Morrión and that is probably the type locality.

Acleisanthes somalensis (Chiov.) R.A. Levin: To trace the interpretation of *Commicarpus somalensis* (Chiov.) Lebrun & Stork (1989) requires access to literature difficult to obtain by those working in the Chihuahuan Desert region. We review the situation here. Lebrun and Stork, in making their new combination, examined a photograph in Chiovenda (1929, Tab. XXXIII, fig. 1) that was labeled as the type of *Selinocarpus somalensis*. The type of that taxon, however, is actually pictured in the adjacent photo (Fig. 2), labeled as *Boerhaavia*

reniformis [now considered *Commicarpus reniformis* (Chiov.) Cufod.]. The captions were switched in Chiovenda's work, as pointed out by Thulin (1994, p. 1111), misleading Lebrun and Stork. The descriptions are valid and the type is indeed a *Selinocarpus* [now as *Acleisanthes somalensis*], as indicated by the molecular data of Levin (2000).

Abronia umbellata var. **breviflora** (Standley) L.A. Galloway, comb. et stat. nov.
BASIONYM: *Abronia breviflora* Standley, Contr. U.S. Natl. Herb. 12:312, plate 30. 1909. TYPE: U.S.A. CALIFORNIA. MENDOCINO CO.: Mendocino, Jun 1989, *H.E. Brown* 833 (HOLOTYPE: US, not seen; ISOTYPE: MO!).

With little exception, the rank of variety has been used for infraspecific taxa in the Nyctaginaceae. The Flora of North America North of Mexico project requires that all infraspecific taxa within a generic treatment be at the same rank. In *Abronia*, and the Nyctaginaceae in general, the rank of variety has been most used and to continue to use rank results in the least nomenclatural disturbance. One transfer from subspecies to variety is necessary. This new combination makes the FNA *Abronia* treatment consistent, replacing *Abronia umbellata* subsp. *breviflora* (Standl.) Munz (Aliso 4:90. 1958).

ACKNOWLEDGMENTS

We thank the following: Jim Zarruchi for providing literature from the Missouri Botanical Garden regarding *Commicarpus somaliensis* and copies of relevant pages of Atlas of Vascular Plants of Texas, Neil Harriman for his opinion regarding the gender of specific epithets when transferred from *Selinocarpus* to *Acleisanthes*, Jim Henrickson and Guy Nesom for helpful comments on a draft manuscript, Roy Gereau for locating an isotype of *Abronia umbellata*, and to Leo Galloway for his patience and attention during the long process of preparing FNA Nyctaginaceae treatment. Leo Galloway has asked us to include this nomenclatural transfer in this note, thus this combination should be regarded as "L.A. Galloway in Spellenb. & Poole."

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Book Review

Lincoln Taiz and Eduardo Zeiger. 2002. **Plant Physiology, Third Edition.** (ISBN 0-87893-823-0, hdbk.). Sinauer Associates, Inc., 23 Plumtree Road, P.O. Box 407, Sunderland, MA 01375. (Orders: www.sinauer.com, 413-549-1118 fax). $104.95, 690 pp., 542 illustrations, 8 1/2" × 11".

The third edition of this highly regarded undergraduate textbook has been revised, updated, and given a facelift. Though preceded by two hefty editions, this third edition is more than 100 pages shorter than the second. The authors, Tiaz and Zeiger, elected to place two chapters on a dedicated website. By using the Internet as a communication tool for some important plant physiology topics, they have included information on energy, enzymes, gene expression and signal transduction in electronic form. Clearly, the website shows the authors' willingness to keep the hard copy version of the text a workable size without compromising its content. Additionally, all figures in this latest version are in full color and subtended by captions containing a wealth of information pertinent to the chapter.

The book is generally divided into three units: *Transport and Translocation of Water and Solutes*, *Biochemistry and Metabolism*, and *Growth and Development*. The first unit begins appropriately with chapters on plant cells, water transport and balance. Other chapters included in this unit are mineral nutrition and solute transport. Unit two is filled with information on metabolic reactions. Chapters in this unit are respiration, assimilation of mineral nutrients, secondary metabolites, and three chapters on photosynthesis. Unit three has chapters on cell walls, hormones, control of flowering, stress physiology, phytochrome and light control of development.

Each chapter is subsequently broken into sections and subsections with headings. These headings would undoubtedly prove helpful for the student, since the headings are written in the form of a single sentence summary, giving the student a 'heads up' on what they are about to read.

The companion website, www.plantphys.net, not only contains two chapters not covered in the textbook, but also has a series of web topics and essays to reinforce the subject-matter covered in the text. A list of web topics and essays at the end of each chapter in the text refer to these readings on the website.

Certainly, this valuable text has been significantly improved for its third edition. The companion website is put together well and is surely an indication of the fate of future textbooks. *Plant Physiology* has clearly set a standard in college science texts and the authors are to be commended for their revisions and editorial work. Without doubt, this book should be a standard text in botany and biology departments.—*Amy Trauth Nare, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX, 76102 U.S.A., amy_trauth@yahoo.com.*

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YUCCA CERNUA (AGAVACEAE: SERIES RUPICOLAE), A NEW SPECIES FROM NEWTON AND JASPER COUNTIES IN EASTERN TEXAS

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ABSTRACT

A new species of *Yucca* from the series Rupicolae is described from Jasper and Newton counties in eastern Texas. Series Rupicolae is distinguished by its characteristically denticulate leaves and beaked fruits. This new species, *Yucca cernua*, sp. nov. is described, illustrated, and distinguished from other acaulescent species in ser. Rupicolae. The combined characteristics of a tall flowering scape; the tendency of the branches of the inflorescence to recurve and droop as they lengthen; the moderately to densely floccose inflorescence; large leaves typically growing erect; relatively short capsules, pistils, and stamens; unique habitat; and disjunct distribution distinguish this species from other acaulescent species in ser. Rupicolae. The rarity of this species warrants its consideration as a candidate for state and federal regulatory protection. Also included is a key of the entire or denticulate, non-filiferous leaved North American species of *Yucca*.

RESUMEN

Se describe una nueva especie de *Yucca* de la serie Rupicolae de los condados Jasper y Newton en el Este de Texas. La serie Rupicolae se distingue por las hojas denticuladas y frutos picudos. Esta nueva especie, *Yucca cernua* sp. nov., se describe, se ilustra y diferencia de las otras especies de la serie Rupicolae. Un conjunto de varias características distingue esta especie de las otras especies acaulescentes de la serie Rupicolae. Estas características son la presencia de un escapo alto con flores, la tendencia de las ramas de la inflorescencia a retorcerse y colgar cuando se alargan, la inflorescencia de mediana a densamente flocosa, cápsulas, pistilos y estambres relativamente cortos, las hojas grandes que típicamente se desarrollan de forma erecta, un hábitat único, y su distribución disyunta. La rareza de esta especie justifica su consideración como candidata para la regulación de protección estatal y federal. También se incluye una clave de todas las especies de Yucca norteamericanas con hojas denticuladas y filíferas.

In May of 2001, an unusual population of *Yucca* was discovered along U.S. Highway 190 in Newton County, Texas. It appeared distinctive because of its tall inflorescence (up to four meters) and the characteristic tendency of the inflorescence branches to recurve and droop as they lengthened. On closer investigation, these plants appeared most similar to *Y. pallida* McKelvey with mostly flat, glaucous, denticulate leaves. No plants were collected because the significance of the population was not recognized at the time. Plants were later collected in flower in June of 2002 and in fruit in November of 2002. It was unknown whether this population was escaped from cultivation, disjunct, or represented

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an undescribed species. After examination of live plants and numerous herbarium specimens of its apparent closest relatives, it was determined to represent a new species. Acronyms of the herbaria cited follow Index Herbariorum (Holmgren et al. 1998).

Yucca cernua Keith, sp. nov. (**Figs. 1, 2**). TYPE: U.S.A. TEXAS. NEWTON CO.: brown, clayey roadside on US Hwy 190, 3/8 mi E of Newton-Jasper County line, plants ranging from 1.5–4 m tall, branches of inflorescence drooping with age, 11 Jun 2002, *Eric L. Keith* 183 (HOLOTYPE: TEX; ISOTYPES: BRIT, SHSU).

A Yuccae pallidae ac Yuccae rupicolae similis fructibus rostratis et marginibus serrulatis foliorum; ab utroque differt inflorescentia elatiore (usque ad 4 m) ramis moderate vel dense floccosis recurvantibus ac cernuentibus simul elongentibus, foliis majoribus (usque ad 80 cm longis ac 6.5 cm latis), pistillis brevioribus (2–2.7 cm), et staminibus brevioribus (1.2–1.7 cm).

Acaulescent, forming large solitary clumps and spreading from thick rhizomes, 1–2 cm diameter. ***Leaves*** (30–)40–70(–80) cm long, (3–)3.5–6.5 cm wide at widest point, greatly narrowed (0.7–1.2 cm) to just above union with base, young leaves glaucous, the lowermost leaves usually undulate and twisting, older leaves becoming yellowish-green to olive green and flat or slightly concave, turning purplish or brown on drying, acute or slightly acuminate, becoming concave and inrolled 0.7–2.5 cm below tip; leaf margins corneous, yellowish and minutely denticulate; spines, 0.3–1 cm long, pungent, yellowish at base and reddish-brown at tip. Inflorescence long-exserted, (1.5–) 2–4 m tall, scape (1.2–)1.5–3.2 m in length; inflorescence panicled, moderately to densely floccose, branched from base to racemose tip; inflorescence branches characteristically recurved and drooping as they lengthen, longest branches to 35 cm long. ***Flowers*** mostly white or slightly greenish white, campanulate, pendant; tepals free, glabrous, outer whorl narrowly elliptic or lanceolate, 3.4–5(–5.8) cm long, 0.75–1.7 cm wide, inner whorl elliptic 3.5–5(–5.8) cm long and 1–1.8 cm wide; stamens 1.2–1.9(–2.2) cm long; filaments reflexed or even slightly twisted or contorted especially on drying, echinate; anthers to 0.7 mm long, sagittate; pistil 2–3 (–3.3) cm long as measured from base of ovary to tip of stigmas; ovary slender, oblong-cylindric, 0.4–0.8 cm diameter; styles 3, 0.8–1.5(–1.7) cm long, erect to slightly spreading, branches usually papillose. ***Fruit*** dry, dehiscent, pendant, 3.2–4.5 cm long, 2–2.5 cm in diameter, symmetrical, oblong-cylindric, at dehiscence splitting for entire length on primary fissures and usually $^1/_4$ to $^1/_2$ of the length of capsule on secondary fissures; beaks 0.5–1 cm in length, usually turned inward at 45° angles where split on secondary fissures (Fig. 1). ***Seeds*** polymorphic, obovate to D-shaped 5–7 mm long and 4–6 mm wide, thicker toward edges, 0.5–1 mm thick.

Etymology.—The epithet refers to the characteristic tendency of the inflorescence branches to recurve and droop as they lengthen, an apparently distinctive feature separating it from all other *Yucca* species.

Habitat and Distribution.—*Yucca cernua* occurs in open or slightly shaded

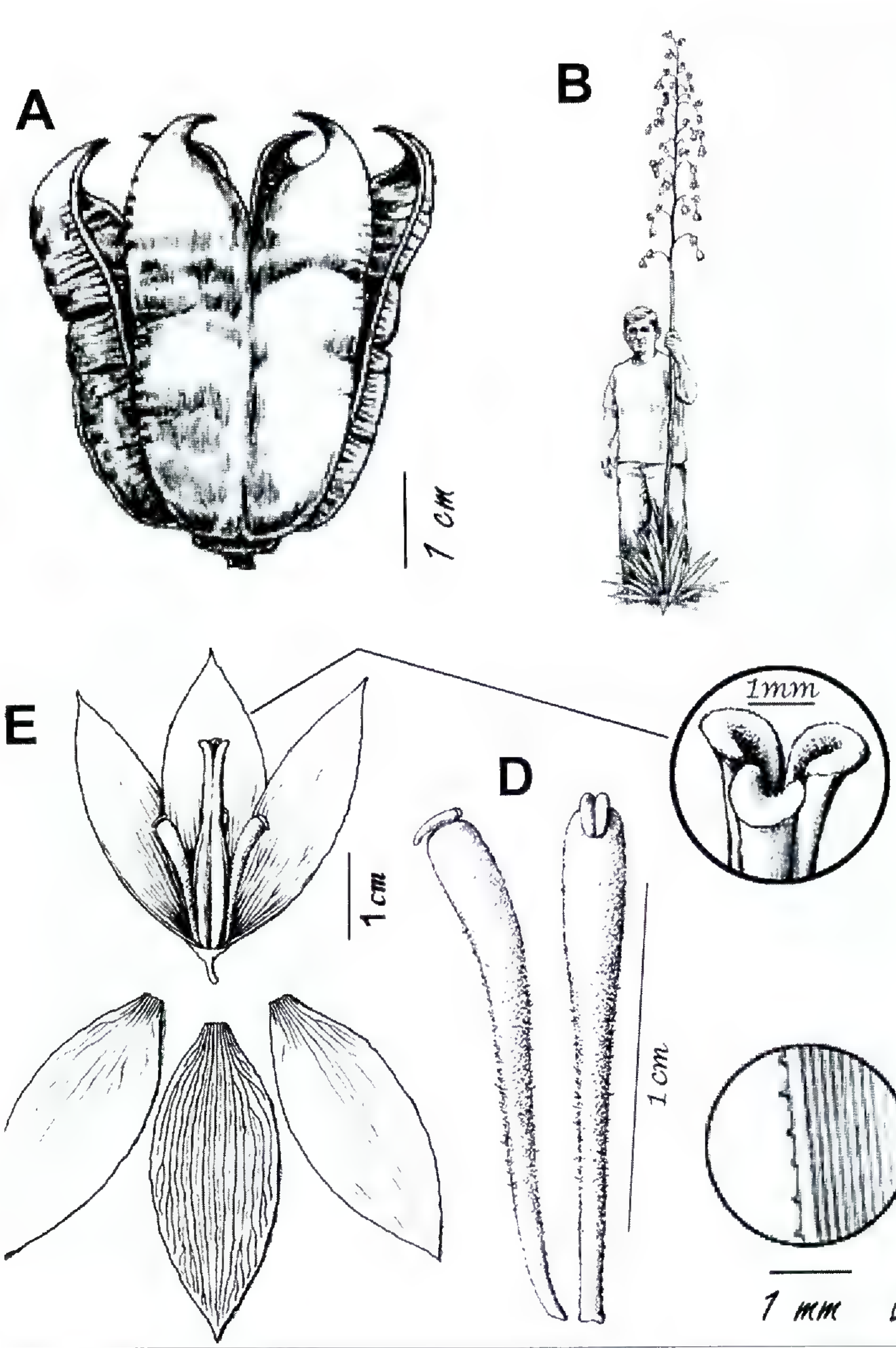


FIG. 1. *Yucca cernua*. **A.** Capsule. **B.** Habit. **C.** Representative leaf, abaxial surface, with leaf margin magnified 11×. **D.** Stamen, front view and side view, slightly enlarged. **E.** Flower; inset detail of stigma lobes.

areas apparently restricted to brownish, acidic clayey soils of the Redco Soil Series in Jasper and Newton counties in eastern Texas (Neitsch 1982). The Redco Soil Series occurs in southeastern Texas from Newton County westward to Walker County (McClintock 1979; Neitsch 1982; USDA 2002). This species is currently known only from an area approximately 6-km^2 centered in west-central Newton County and just into the far eastern portion of Jasper County. One large population of approximately 1000 plants and six small populations









FIG. 2. *Yucca cernua* Keith. **A.** Young leaves glaucous. Note lower leaves slightly undulate and twisting. **B.** Older leaves yellowish-green or olive and flat. **C.** Inflorescence recurved and drooping. **D.** Habit.

of less than a 100 plants each are known. In 1987, Thomas and Allen collected this species (labeled as *Yucca* sp.) at the type locality. A 1951 collection of *Y. cernua* (labeled as *Yucca*) at the Botanical Research Institute of Texas (BRIT) from Jasper County indicates that it was collected in the town of Jasper. This population, if still extant, is at least five miles west of any known location. No other collections of this species are known. This species is apparently tolerant of soil disturbance. All of the plants are found along roadsides and other disturbed areas, and it rapidly colonizes areas with bare soil. It is hoped that more populations will be found throughout southeastern Texas in similar habitats.

Associated species.—*Eurybia hemisphaerica* (Alexander) Nesom, *Helianthus angustifolius* L., *Panicum anceps* Michx., *Solidago canadensis* L., *Tridens strictus* (Nutt.) Nash, *Smilax bona-nox* L., *Pinus taeda* L., *Symphyotrichum lateriflorum* (L.) A.&D. Löve, *Symphyotrichum dumosum* (L.) Nesom, *Carex flaccosperma* Dewey, *Liquidambar styraciflua* L., *Ilex vomitoria* Ait., and *Coreopsis* sp.

Additional collections examined: U.S.A. **TEXAS. Jasper Co.:** Jasper, leaves up to 69 cm long and 4 cm broad; terminal spine 5–7 mm long, 20 Jul 1951, *H.R. Reed 1238* (BRIT). **Newton Co.:** on S side of U.S. 190, 8.8 mi E of Texas 63 intersection near Jasper and 4.3 mi W of Newton, Texas, top of dry, sandy hill on S side of U.S. 190, 07 Sep 1987, *R. Dale Thomas & Charles M. Allen 101823* (NLU).

Yucca cernua is a very distinctive species adapted to a unique soil type. It appears to be closely related to *Y. pallida* and *Y. rupicola* Scheele in the series Rupicolae and which it most closely resembles by its acaulescent habit, denticulate leaves, and beaked capsules (Hess & Robbins 2002; McKelvey 1947; Trelease 1902). The closest known populations of either species are over 300 km to the west and northwest of *Y. cernua* (Correll & Johnston 1970; Diggs et al. 1999; Hochstaetter 2000; McKelvey 1947).

Table 1 provides a list of the major differences between these three species. To date, our understanding of the species indicates that it is endemic to this region and is extremely rare. Adverse impacts to this population described above could pose serious threats to the continued existence of the species. All known populations of *Yucca cernua* are found on private land and public highway rights-of-way and are not currently protected. Fortunately, a preliminary agreement with a private landowner will set aside a preserve along both sides of Highway 190 where the largest population occurs. Since this species appears to have a very restricted distribution based on unique soil requirements, it should be considered as a candidate for federal and state protected species status.

Included herein is a key of the entire or denticulate, non-filiferous leaved North American species of *Yucca*. Key is derived from Hess and Robbins (2002) and personal observations.

1. Mature plants caulescent; rosettes each with more than 100 leaves; distribution in western Texas.
   2. Mature plants 2.5–3.6 m, not including inflorescence; leaf blade 25–60 × 1.2–1.7 cm, widest considerably above middle, smooth _____ **Yucca rostrata**

TABLE 1. A comparison of *Yucca cernua*, *Yucca pallida*, and *Yucca rupicola*. Characters are taken from personal observations, Diggs et. al (1999), Hess and Robbins (2002), and McKelvey (1947).

Feature	*Yucca cernua*	*Yucca pallida*	*Yucca rupicola*
Distribution	Jasper and Newton counties in eastern Texas	Central Texas northward to North Central Texas	Edwards Plateau
Habitat	Acidic clays of the Redco Soil Series	Open areas on limestone outcrops	On limestone ledges and plains
Leaf dimensions	(30–)40–70(–80) cm long, (3–)3.5–6.5 cm wide at widest point	18–35(–56) cm long, (1.0–) 2.5–3.2(–4.5) cm wide at widest point	25–60(–82) cm long, (1.7–) 2.3–5(–6) cm wide at widest point
Leaf characteristics	Most leaves flat except green lowermost leaves which are usually undulate and twisted, young leaves glaucous becoming olive or yellowish with age	Most leaves flat and persistently blue-green glaucous	Most leaves olive-green and undulate and twisted
Spine characteristics	Yellow at base, reddish brown at tip	Mostly all yellow, occasionally slightly reddish near base	Orange, yellowish-brown, or reddish-brown
Inflorescence height	(1.5–)2–4 m tall	1.3–2.5 m tall	1.5–3.6 m tall
Inflorescence characteristics	Moderately to densely and floccose, branches recurved and drooping	Glabrous and glaucous, branches wide-spreading	Glabrous or slightly pubescent, branches erect-ascending
Tepal dimensions	3.4–5(–5.8) cm long, 0.75–1.8 cm wide	(3.6–)5 -6.5 cm long, (1.5–) 2–3.2 cm wide	(4–)5.5–8.2 cm long, (1.4–) 2–3.2 cm wide
Pistils **Stamens** **Capsules**	2–3(–3.3) cm long 1.2–1.9(–2.2) cm long 3.2–4.5 cm long	2.4–4 cm long 2.1–3.2 cm long 3.8 5 cm long	2.7–4 cm long 1.8–2.8 cm long 4.8–7.5 cm long
Capsule beaks	0.5–1 cm long, usually turned inward at 45° angles where split on secondary fissures	0.8–1.2 cm long, usually erect	0.9–1.2 cm long, erect or slightly reflexed

2. Mature plants 0.7–2.5 m, not including inflorescence, leaf blade 20–30(–45) × 0.7–1.2 cm, widest at or above middle, ± scabrous _____ **Yucca thompsoniana**

1. Mature plants acaulescent, usually forming colonies; rosettes each with fewer than 100 leaves.
   3. Mature leaf blade undulate and twisted, strongly concave, margins orange or yellowish-brown to reddish-brown; endemic to eastern Edwards Plateau _____ **Yucca rupicola**
   3. Mature leaf blade straight (lowermost leaves usually twisted in. *Y. cernua*), flat or slightly concave, margins yellow or reddish brown.
      4. Mature leaf blades 1–2(–2.5) cm at greatest width, inflorescence densely floccose with branchlets spreading or ascending; endemic to western Edwards Plateau _____ **Yucca reverchonii**
      4. Mature leaf blades (1–)2.5–6.5 cm at greatest width, inflorescence either moderately to densely floccose with recurved and drooping branchlets or glabrous with wide-spreading branchlets.
         5. Plants in colonies of 10–30 rosettes each, leaves (1–)2.5–3.2(–4.5) cm at greatest width, persistently blue-green glaucous, inflorescence glabrous with wide-spreading branchlets; endemic to central and north-central Texas _____ **Yucca pallida**
         5. Plants usually solitary, leaves (3–)3.5–6.5 cm at greatest width, young leaves glaucous becoming olive or yellowish-green with age, inflorescence floccose with recurved and drooping branchlets; apparently endemic to eastern Texas _____ **Yucca cernua**

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TWO NEW SPECIES OF *PARATHESIS* (MYRSINACEAE) FROM MESOAMERICA AND NEOTYPIFICATION OF *PARATHESIS ROTHSCHUHIANA*

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ABSTRACT

Two new species of *Parathesis*, *P. pseudocalophylla* Ricketson & Pipoly from Chiapas, Mexico, and *P. pseudocrassiramea* Ricketson & Pipoly from San José, Costa Rica, are described and illustrated. Further revision of the genus has revealed the necessity of neotypifying *P. rothschuhiana* Mez.

RESUMEN

Se describen y se ilustran dos especies nuevas pertenecientes al género *Parathesis*, *P. pseudocalophylla* Ricketson et Pipoly, y *P. pseudocrassiramea* Ricketson et Pipoly, provenientes de Chiapas, México y San José, Costa Rica. Además, se neotipifica *P. rothschuiana* Mez.

The genus *Parathesis* (A. DC.) Hook. f. contains 95 species distributed from northern Mexico to Panama, the Caribbean, and throughout the Andes from Venezuela to Bolivia and adjacent Brazil. The genus is defined by the unique glandular papillae of the corolla lobes, and bright yellow anthers. In preparing the treatment of the genus *Parathesis* for *Flora Mesoamericana*, two new species were discovered, and are described herewith.

Parathesis pseudocalophylla Ricketson & Pipoly, sp. nov. (**Fig. 1**). TYPE: MEXICO. CHIAPAS: Mpio. La Independencia, third ridge along logging road from Las Margaritas to Campo Alegre, 2,300 m, 3 Jul 1981 (fl.), *D. Breedlove 51314* (HOLOTYPE: MO; ISOTYPES: CAS, LL).

Quoad laminam bullatam inflorescentiam lateralem *P. calophyllae* valde affinis, sed ab ea ramulis pedunculis laminisque rigide rufo (non adpresse ferrugineo-) arachnoideo- dendroideo-tomentosis, petiolis 0.7–1.5 (non 2.8–3.4) cm longis, calyce 1.6–1.8 (non 2.2–2.4) mm longo, corolla 6.1–6.3 (non 7.2–7.5) mm longa, atque staminium 4.5–4.7 (non 4.3–4.5) mm longarum, filamentis 2.9–3.1 (non 2.5–2.7) mm longis, ac antheris lanceolatis (non ovatis) 2–2.2 (nec 1.8–2.1) mm longis statim separabilis.

Trees to 6.1 m tall. ***Branchlets*** slender, angulate, 3–6 mm in diam., densely and stiffly rufous arachnoid and dendroid tomentose. ***Leaves***: with blades chartaceous to subcoriaceous, elliptic, 8.8–14.4 cm long, 2.2–4.7 cm wide, apically acuminate, the acumen 0.6–1.6 cm long, basally acute, decurrent on the petiole, conspicuously and prominently punctate and punctate-lineate, glabrous above except scattered to densely rufous dendroid tomentose at the base and along the midrib, with scattered arachnoid and dendroid trichomes below

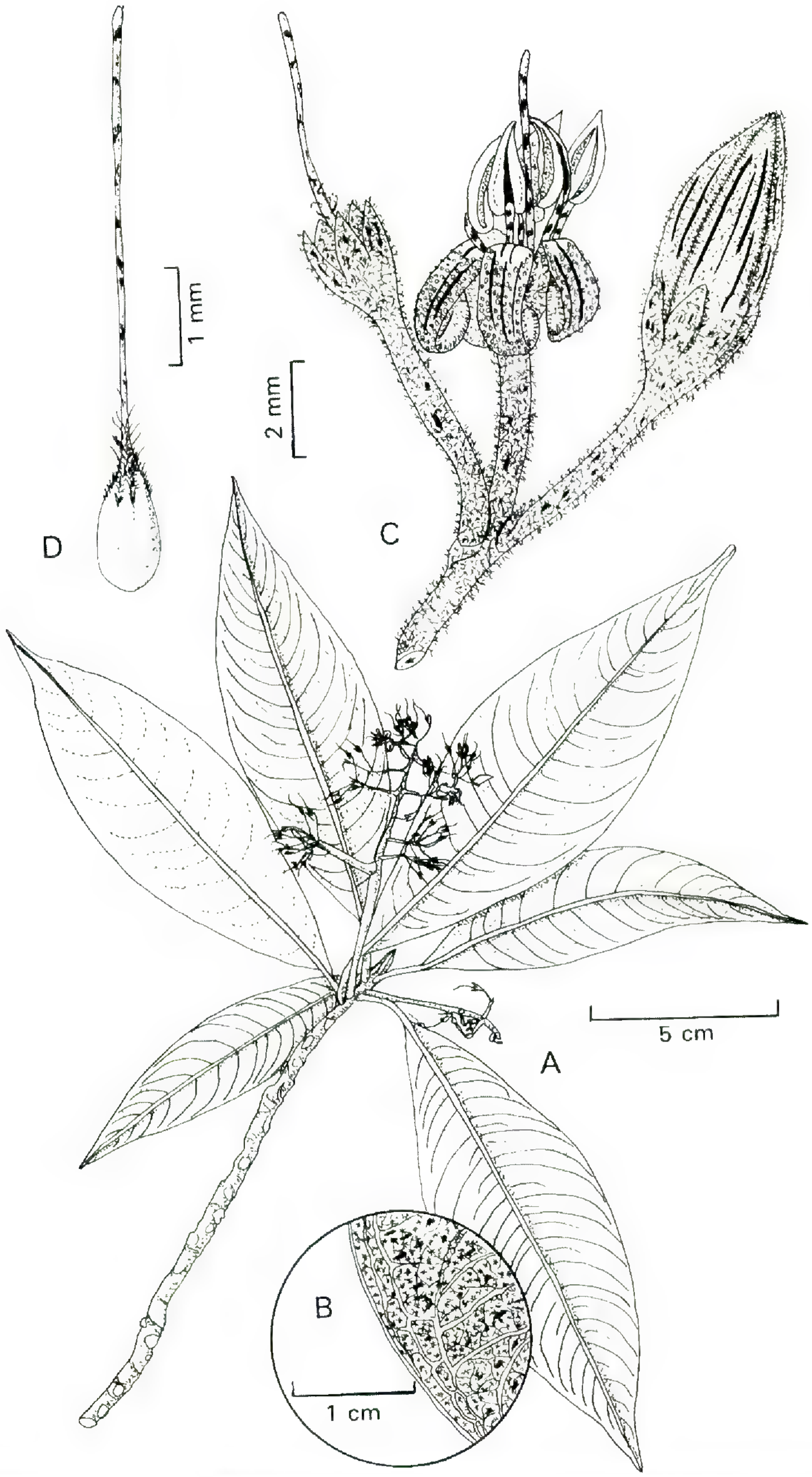


FIG. 1. *Parathesis pseudocalophylla* Ricketson & Pipoly. **A.** Flowering branch. **B.** Detail of abaxial leaf surface. **C.** Detail of inflorescence. **D.** Pistil. A–D drawn from holotype, *D. Breedlove 51314* (MO).

except densely so along the midrib, the midrib impressed above, prominently raised below, the secondary veins 20–27 pairs, slightly bullate above, prominently raised below, the margins entire; petioles slender, marginate, 0.7–1.5 cm long, vestiture as in the branchlets. ***Inflorescences*** lateral, pinnate to bipinnately paniculate, 3.5–9.5 cm long, 2–5 cm wide, pyramidal, shorter than the leaves, the rachis with a vestiture as in the branchlets, the branches 3–7-flowered corymbs; peduncles 2.2–5.1 cm long; inflorescence bracts unknown; inflorescence branch bracts caducous, membranous, ovate to lanceolate, 1.8–2.1 cm long, 0.7–0.9 mm wide, apically acute, conspicuously and prominently punctate and punctate-lineate, glabrous adaxially, densely arachnoid and dendroid tomentose abaxially, the veins inconspicuous, the margins entire; floral bracts similar to the inflorescence branch bracts but, 0.9–1.6 mm long, 0.3–0.5 mm wide; pedicels slender, angulate, 4.3–5.5 mm long, conspicuously and prominently punctate and punctate-lineate, vestiture as in the branchlets. ***Flowers*** 5-merous; calyx chartaceous, 1.6–1.8 mm long, the tube 0.3–0.5 mm long, the lobes ovate, 1.1–1.3 mm long, 0.8–1 mm wide, apically acute, conspicuously and prominently punctate and punctate-lineate, glabrous within, scattered to densely pubescent with simple trichomes, the margins entire; corolla pink, chartaceous, 6.1–6.3 mm long, the tube 0.6–0.8 mm long, the lobes lanceolate, 5.4–5.7 mm long, 1.2–1.5 mm wide, apically attenuate, conspicuously and prominently punctate and punctate-lineate, glandular-papillose within except glabrous at the very base, scattered to densely pubescent with simple trichomes, the margins entire; stamens 4.5–4.7 mm long, the filaments 2.9–3.1 mm long, the staminal tube 0.7–0.8 mm long, the apically free portion 2.1–2.3 mm long, conspicuously and prominently punctate and punctate-lineate, glabrous, the anthers yellow, erect, basifixed, lanceolate, 2–2.2 mm long, 0.7–0.9 mm wide, apically acute, apiculate, basally cordate, the connective conspicuously and prominently punctate and punctate-lineate; pistil 5.9–6.2 mm long, the ovary ovate, 1.1–1.3 mm long, inconspicuously punctate and punctate-lineate, glabrous except apically of scattered to densely villous or pilose of simple multicellular trichomes, the style 4.7–4.9 mm long, conspicuously and prominently punctate and punctate-lineate, glabrous except basally with scattered to densely villous or pilose of simple multicellular trichomes, the ovules 6–8, uniseriate. ***Fruits*** unknown.

Distribution.—*Parathesis pseudocalophylla* is only known from the type collection, between Las Margaritas to Campo Alegre, in the Mpio. of La Independencia, Chiapas, Mexico, growing at 2300 m elevation.

Ecology and conservation status.—*Parathesis pseudocalophylla* occurs in evergreen cloud forests, with *Pinus*, *Quercus*, *Magnolia*, *Podocarpus*, *Photinia* and *Olmediella*. Because it was collected along a logging road, it should be considered threatened.

Etymology.—The specific epithet comes from it close affinity to *Parathesis calophylla*.

Parathesis pseudocalophylla was at first confused with *P. calophylla* because of the chartaceous to subcoriaceous, slightly bullate leaves, and lateral inflorescences. However, *P. calophylla* has densely appressed ferrugineous arachnoid or dendroid trichomes forming a tomentum, while in *P. pseudocalophylla*, the hairs are erect, stiff and rufous. In addition, *P. pseudocalophylla* has shorter petioles and perianth parts, but significantly longer stamens to 4.7 mm long, and larger lanceolate instead of ovate anthers to 2.2 × 0.9 mm.

Parathesis pseudocrassiramea Ricketson & Pipoly, sp. nov. (**Fig. 2**). TYPE. COSTA RICA. SAN JOSÉ: Cantón de Pérez Zeledón, Parque Nacional Chirripó, Cuenca Térraba-Sierpe, Estación Santa Elena, 09° 23' 36" N, 083° 35' 21" W, 1,300–1,400 m, 17 Sep 1997 (fr.), *E. Alfaro 1431* (HOLOTYPE: INB; ISOTYPES: CR, MO).

Ob laminam bullatam inflorescentiam terminalem necnon ovarium dense adpresseque tomentosum *P. crassirameae* valde affinis, sed ab ea ramulis 8–10 (non 2–5) mm diametris minute papilloso- vel glandulari-granuloso- (non multicellulo- vel stellato-) tomentosis, lamina foliari 18–25 (non 5.8–18.2) cm longa, 7.9–10.5 (nec 1.8–6.3) cm lata, ad apicem acumine 1–1.8 (nec 0.3–1) cm longo, calyce 1.2–1.7 (non 1.7–1.9) mm longe, antheris 1.5–1.8 (non 2.2–2.4) mm longis perfacile recognoscitur.

Trees 6 m tall. ***Branchlets*** stout, angulate, 8–10 mm in diam, densely appressed papillose- or glandular-granulose-tomentose, glabrescent with age. ***Leaves***: with blades coriaceous, elliptic to oblong, 18–25 cm long, 7.9–10.5 cm wide, apically obtuse, abruptly acuminate, the acumen 1–1.8 cm long, basally obtuse to rounded, decurrent on the petiole, bullate, conspicuously and prominently punctate and punctate-lineate, glabrous above, essentially glabrous below but with sparse papillae or glandular granules at the very base, the midrib impressed above, prominently raised below, the secondary veins 80–110 pairs, conspicuously impressed above, prominently raised below, the margins entire, enrolled; petioles slender, marginate, 2.8–3.6 cm long, glabrous above, appressed papillose- or glandular-granulose-tomentose below, glabrescent with age. ***Inflorescences*** terminal and in the axils of the uppermost leaves, pinnate to bipinnately paniculate, 27–28 cm long, 22–25 cm wide, pyramidal, as long or longer than the leaves, the rachis tomentose as in the branchlets, the branches 3–7-flowered corymbs; peduncles nearly absent to 1 cm long, the lower branches subtended by leaves; inflorescence bracts unknown; inflorescence branch bracts unknown; floral bracts caducous, membranous to chartaceous, ovate, 0.9–1.5 mm long, 0.5–1 mm wide, apically acuminate, basally sessile, conspicuously and prominently punctate and punctate-lineate, glabrous adaxially, vestiture as in the branchlets abaxially, the veins inconspicuous, the margins entire; pedicels stout, angulate, 1–2.5 mm long, conspicuously and prominently punctate and punctate-lineate, vestiture as in the branchlets. ***Flowers*** 5- to 6-merous; calyx chartaceous, 1.2–1.7 mm long, the tube 0.2–0.4 mm long, the lobes ovate, 0.9–1.5 mm long, 1–1.4 mm wide, apically long acuminate, conspicuously and prominently punctate and punctate-lineate, glabrous within, vestiture as in the branchlets, the margins entire; corolla color unknown, chartaceous to coria-

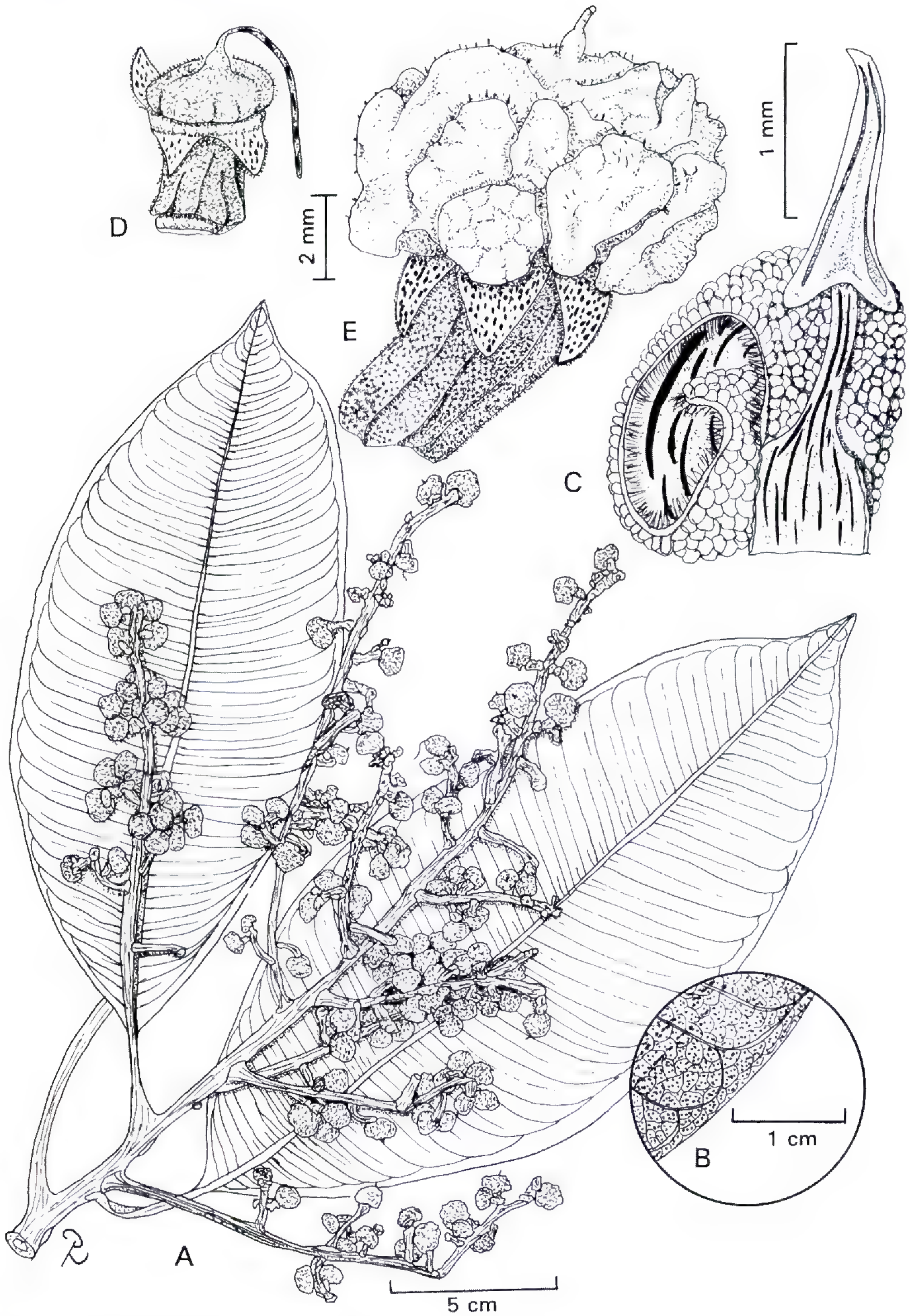


FIG. 2. *Parathesis pseudocrassiramea* Ricketson & Pipoly. **A.** Flowering branch. **B.** Detail of abaxial leaf surface. **C.** Detail of flower, showing corolla lobe with glandular papillae and stamen. **D.** Flower with immature fruit. **E.** Fruit. A–E drawn from isotype, *E. Alfaro 1431* (MO).

ceous, 5–5.2 mm long, the tube, 0.8–1 mm long, the lobes linear-lanceolate, 4.1–4.3 mm long, 1–1.2 mm wide, apically long acuminate, conspicuously and prominently punctate and punctate-lineate, densely tomentose near the base within, the margins entire; stamens 2.8–3 mm long, the filaments 1.8–2 mm long, the staminal tube 0.5–0.7 mm long, the apically free portion 1.2–1.4 mm long, conspicuously and prominently punctate and punctate-lineate, glabrous, the anthers yellow, 1.5–1.8 mm long, 0.6–0.8 mm wide, apically acuminate, apiculate, basally sagittate, the connective, conspicuously and prominently punctate and punctate-lineate; pistil 4.3–4.6 mm long, the ovary ovate, 0.9–1 mm long, conspicuously and prominently punctate and punctate-lineate, densely tomentose with appressed simple or stellate trichomes, the style 3.4–3.6 mm long, conspicuously and prominently punctate and punctate-lineate, glabrous, the ovules unknown. ***Fruits*** depressed globose, 4–5 mm long, 6–9 mm wide, conspicuously and prominently punctate and punctate-lineate, densely puberulent of finely appressed simple or stellate trichomes, inconspicuously costate.

Distribution.—Parathesis pseudocrassiramea is only known from the type collection in the Parque Nacional Chirripó, San José, Costa Rica, growing from 1300–1400 m elevation.

Ecology and conservation status.—Parathesis pseudocrassiramea occurs in premontane forests. Although it seems protected in the Chirripó National Park, it is only known from the type collection and should be considered threatened at this time.

Etymology.—The specific epithet comes from it close affinity to *Parathesis crassiramea.*

The type is in fruit with few partial remnant flowers and buds. The remaining buds appear to house insects, thus bud measurements are inaccurate. The fruits are unusual in the genus and appear as a "cauliflower" shape, however this may be strictly because they were "juicy" at the time of collecting and the "wrinkled" nature may be caused by the drying process.

Parathesis pseudocrassiramea is closely related to *P. crassiramea* because of the bullate leaves, terminal inflorescences, and the ovary densely puberulent with finely appressed simple or stellate trichomes. The leaf blades of *P. pseudocrassiramea* are larger, to 25 × 10.5 cm, and essentially glabrous below but with a few papillae or glandular granules at the very base, while in *P. crassiramea* they are inconspicuously to conspicuously bizonal below with the marginal zone glabrous and the costal zone sparsely to scattered fine appressed with whitish stellate trichomes. In fruit, *P. pseudocrassiramea* may also be confused with *P. cartagoana*; however, the vestiture of the lower leaf surface is inconspicuously or conspicuously bizonal and the marginal zone is strongly appressed with dense, canescent stellate or dendroid trichomes and the costal zone has a mixture of appressed, dense, canescent or ferrugineous to tomentose stel-

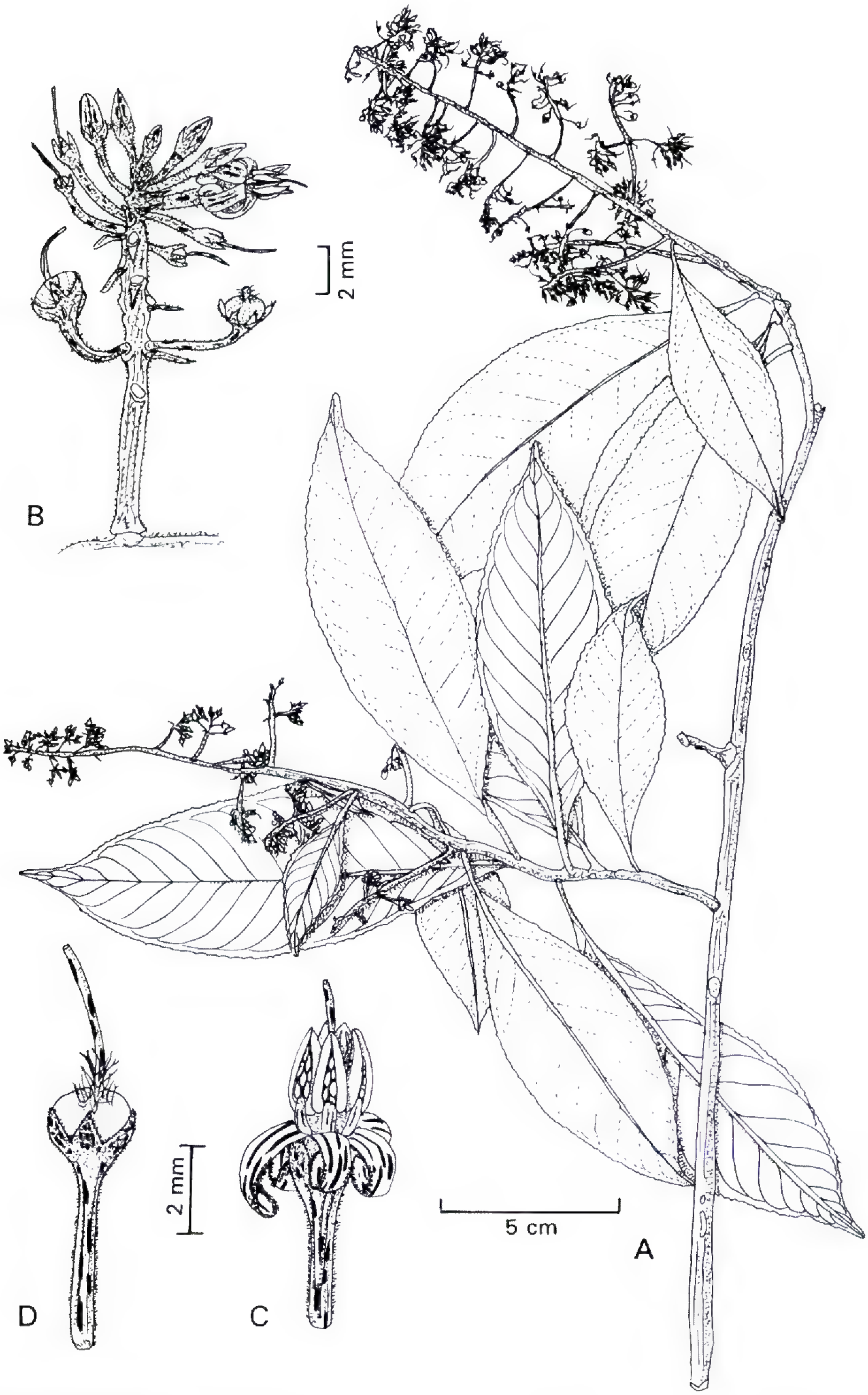


FIG. 3. *Parathesis rothschuhiana* Mez. **A.** Flowering branch. **B.** Detail of inflorescence. **C.** Flower. **D.** Fruit. A–D drawn from *J. Atwood & D. Neill 14* (MO).

late and/or dendroid trichomes with scattered erect reddish dendroid trichomes, which immediately separate the two taxa.

In addition to the aforementioned novelties, revision of the genus disclosed the necessity of neotypifying *Parathesis rothschuhiana* Mez.

Parathesis rothschuhiana Mez, Pflanzenr. IV. 236 (Heft 9):176. 1902. (**Fig. 3**). TYPE. NICARAGUA. MANAGUA: Grenze der Berg und savannenregion, 550 m, 9 Mar 1894 (fl., fr.), *E. Rothschuh 531* (HOLOTYPE: B destr. 1943, F neg.4875); NEOTYPE. NICARAGUA. NUEVA SEGOVIA: a la orilla del Río Achuapa al S del Cerro Mogotón, 1,500 m, 12 Jun 1975 (fl.), *J. Atwood & D. Neill 14* (NEOTYPE, here selected: MO; ISONEOTYPE: FTG).

Ardisia fusca Oerst. var. *glabrata* Oerst., Vidensk. Meddel. Dansk Naturhist. Føren Kjøbenhavn 1861:128. 1862. TYPE. NICARAGUA. JINOTECA: sylvis humidis monte Pantasmo, [13° 28' N, 85° 54' W], 3,000–4,000 leg [914–1,219 m], Jan 1848 (fl.), *A. Oersted 37A* (HOLOTYPE: C; ISOTYPE: LL).

The holotype of *Parathesis rothschuhiana* was destroyed at Berlin (B) in March 1943, thus necessitating the need to located an isotype. Unfortunately, the *E. Rothschuh* specimens were not widely distributed, the only other institutions known to house his material are Leiden (L) and the Smithsonian (US). Searches of these herbaria, as well as the National Herbarium of Nicaragua (HNMN), have failed to locate a duplicate specimen. In the absence of any original type material a neotype must be selected. The *J. Atwood & D. Neill 14* material is in good condition with mature flowers and young fruits. Unfortunately, a search by Alfredo Guijalva (HNMN) of Nicaraguan herbaria has failed to locate a duplicate of this specimen. Thus we hereby designate the *J. Atwood & D. Neill 14* sheet at MO as the neotype.

Oersted (1862) was the first to recognize the unique characters of this taxon, when he described *Ardisia fusca* Oerst. var. *glabrata* Oerst. However, Mez (1902) misunderstood the material and synonymized the variety under *Parathesis fusca* (Oerst.) Mez and failed to recognize the similarities between the type of *Ardisia fusca* Oerst. var. *glabrata* Oerst. with his new species *P. rothschuhiana* Mez. Lundell (1966) in his revision of the genus was the first to synonymize the taxon under *Parathesis rothschuhiana* but was unable to locate any type material.

ACKNOWLEDGMENTS

We wish to thank the Missouri Botanical Garden (MO), Gerrit Davidse (MO) and the *Flora Mesoamericana* Project for its support, to bring Ricketson and Pipoly together to work on the project. We gratefully acknowledge the loans from the herbaria that made this study possible, along with our collaborators who supplied us with much critical material. We also gratefully wish to thank Alfredo Guijalva (HNMN) for his diligent search for specimens in Nicaragua. Thanks are due to Roy Gereau (MO) for comments on the Latin diagnosis. Gerrit Davidse and Zachary Rogers (MO) generously gave of their time to provide thorough reviews of the manuscript.

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OERSTED, A.S. 1862. Myrsineae Centroamericanae et Mexicanae. Vidensk. Meddel. Dansk Naturhist. Føren Kjøbenhavn 1861:117–142, tabs. 1 & 2.

Book Review

William T. Stearn. 2002. **The Genus *Epimedium* and Other Herbaceous Berberidaceae including the Genus *Podophyllum*.** (ISBN 0-88192-543-8, hdbk.) Timber Press, Inc., 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527. (Orders: www.timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $49.95, 354 pp, 27 color paintings, 75 color photos, 31 line drawings, 7 b/w photos, 7 3/8" × 9 5/8".

Though *Epimedium* species have been cultivated for centuries in Asia, it is only relatively recently that the taxonomy has been understood, indeed in great part to the author of this book. William Stearn, who is probably best known for his other books, *Botanical Latin* and *Dictionary of Plant Names for Gardeners*, provides in his posthumous publication a comprehensive monograph of *Epimedium* species and cultivated hybrids. Other herbaceous Berberidaceae genera are treated in this book as well, including *Achlys, Bongardia, Caulopyhllum, Diphylleia, Gymnospermium, Jeffersonia, Leontice, Ranzania*, and *Vancouveria*. A treatment of 14 species of *Podophyllum* is provided by Julian Shaw.

A historical introduction begins the book, in addition to a general description of the herbaceous genera in Berberidaceae and a key to these genera. The second chapter is filled with facts on touted medicinal properties, discovery and treatment of new species by 18th century botanists, and modern hybridization of species for cultivation. Interestingly, the genus was first described by Linneaus in 1753 when he described *Epimedium alpinum*, but it remained monotypic until 1821. Chapter three is a extensive description of morphologic characters, including rhizome, stem, foliage, flowers and fruits. Stearn elaborates on the importance of floral morphology with three extensive figures that include line drawings of the flowers and spurred petals of each species. Next, Stearn explains his classification system for *Epimedium*, which comprises two subgenera and four sections and his biogeographical hypotheses for present distributions of *Epimedium*. The taxonomic treatment of *Epimedium* in chapter seven is comprehensive, beginning appropriately with a key to species and following with descriptions of 54 species and 20 hybrids. Each species description includes eponymy, synonymy, diagnostic characteristics, illustration citations and geographic distribution. In addition, each species has an illustration and/or a color photograph to accompany the text. The rest of the book is dedicated to description of the other aformentioned herbaceous taxa. Descriptions of these taxa follow the same format as *Epimedium*.

Commonly called Barren-worts, *Epimedium* species are increasingly popular in North American landscapes and woodland gardens. Clearly, Stearn himself was interested in the horticulture of herbaceous Berberidaceae, since this book is littered with comments on the history of their cultivation. The comprehensive information provided here by Stearn and collaborators makes it a worthwhile read for a variety of audiences. The importance of this book to taxonomy notwithstanding, people interested in species of herbaceous Berberidaceae, the origins of *Epimedium* and other taxa, and the cultivation of hybrids should consider adding this book to their library.—*Amy Trauth Nare, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX, 76102-4060, U.S.A., amy_trauth@yahoo.com.*

SIDA 20(3): 908. 2003

LECTOTYPIFICATION OF SCHLECHTENDAL MYRSINACEAE FROM SCHIEDE AND DEPPE COLLECTIONS

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ABSTRACT

Ardisia escallonoides, *Myrsine myricoides* and *Parathesis melanostricta* (Myrsinaceae), are lectotypified, based on Schiede and Deppe collections housed at HAL.

RESUMEN

Se lecotipifican *Ardisia escallonoides*, *Myrsine myricoides* y *Parathesis melanostricta* (Myrsinaceae), en base a colecciones de Schiede y Deppe guardados en el herbario HAL.

INTRODUCTION

C.J.W. Schiede and F. Deppe collected in central Mexico between 1828 and 1836, and sent those collections to D.F.L. von Schlechtendal in Berlin (now B). Schlechtendal with A. von Chamisso determined the material and published the results in a series of papers in *Linnaea*. However, in 1833 Schlechtendal moved from Berlin to become the Director of the Botanical Garden and professor of botany at Friedrichs-Universität (since 1933 Martin-Luther-Universität) in Halle, Germany. He transferred his private herbarium to Halle, which contained numerous duplicates of collections from B. After his death in 1866, his private herbarium was acquired by the university and merged with the university herbarium (now known as HAL). Given that the herbarium in Berlin was destroyed in 1943 during World War II, we cannot be sure whether Schlechtendal transferred the types for the new species of Myrsinaceae to HAL when he moved, or brought only duplicates. Therefore, the only choice we have is to lecotypify his names with the duplicates at HAL that bear notes handwritten by Schlechtendal. Lecotypifications are as follows:

Ardisia escallonioides Schltdl. & Cham., Linnaea 6:393. 1831. *Tinus escallonioides* (Schltdl. & Cham.) Kuntze, Revis. Gen. Pl. 2:974. 1891. TYPE: MEXICO. VERACRUZ: in sylvis Papantlae [Papantla], without elev., Dec 1828 (fl., fr.), *C. Schiede & F. Deppe 1226* (LECTOTYPE, here designated: HAL accession number 89724-A + B; ISOLECTOTYPES: K, MO (LL neg. 1971-39), W).

We here by designate the collection at HAL, accession number 89724 A+B as the lectotype.

Myrsine coriacea (Sw.) R. Br. ex Roem. & Schult. *Myrsine myricoides* Schltdl., Linnaea 8:525. 1834. *Rapanea myricoides* (Schltdl.) Lundell, Wrightia 3:109. 1964. TYPE. MEXICO. VERACRUZ: Jalapae [Jalapa], without elev., May 1829 (fr.), *C. Schiede 175* (LECTOTYPE, here designated: HAL accession number 89723-Bogen A/AB; ISOLECTOTYPES: HAL 89723-Bogen B/AB, MO).

Myrsine myricoides Schltdl. has been considered a synonym of *M. coriacea* (Sw.) R. Br. ex Roem. & Schult. for some time. In our previous publications Pipoly (1992a), Ricketson & Pipoly (1997,1999) we erroneously attributed the type to *H. Galeotti 521, 522 and 526* based on Mez's (1902) list of species. Lundell (1964) also failed to designate a lectotype when he placed this species in the now synonymized genus *Rapanea*, see: C. Chen and Pipoly (1996), Pipoly (1991, 1992a, 1992b, 1996) and Pipoly and C. Chen (1995). It is now clear that Schlechtendal based his new species solely on the *C. Schiede 175* collection. As noted above, HAL has two specimens of this collection, we here by designate the specimen with the hand written label (in Schiede's hand) that states, "175, Myrica jalapensis form., Jalapae, Maj. 29." This specimen also includes a label from Schlechtendal "*Myrsine myricoides* n. sp." and a determination slip from Carl Mez, 1901 determined as *Rapanea ferruginea* [(Ruíz & Pav.)] Mez. The HAL isolectotype does not have a locality label with only the Schlechtendal's hand written label stating "175, *Myrsine myricoides*" without the "n. sp." addition. This lends further evidence for selecting the specimen with the hand written locality label.

Parathesis melanostricta (Schltdl.) Hemsl., Biol. Centr.-Amer., Bot. 2:291. 1881. *Ardisia melanostricta* Schltdl., Linnaea 8:526. 1834. TYPE. MEXICO. VERACRUZ: In sylvis inter San Salvador et Jalapam, Jun 1829 (fl.), *C. Schiede 178* (LECTOTYPE: HAL; ISOLECTOTYPES: G (F neg. no. 26685), GH, MO, NY (LL neg. no. 1217), W).

We here by designate the HAL collection, accession number 95759, as the lectotype.

ACKNOWLEDGMENTS

We are most grateful to Uwe Braun of Martin-Luther-Universität, Curator of the HAL herbarium, for his advice and photocopying of the Schlechtendal specimens. We are also grateful to Gerrit Davidse and the Flora Mesoamericana project (MO) and Fairchild Tropical Garden for support of our joint work. Both Braun and Davidse generously gave of their time to provide thorough reviews of the manuscript.

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Ricketson, J. and J. Pipoly. 1999. The genus *Myrsine* (Myrsinaceae) in Venezuela. Sida 18: 1095–1144.

BOOK NOTICES

DAVID YETMAN. 2002. **The Guarijíos of the Sierra Madre: hidden People of Northwestern Mexico.** (ISBN 0-8263-2234-4). University of New Mexico Press, 1720 Lomas Boulevard NE, Albuquerque, NM 87131-1591, U.S.A. (Orders: 1-800-249-7737; 1-505-277-9270 fax.) $49.95, 270 pp., numerous b/w photos, 1 map, 8 1/2" × 11 1/4".

The Guarijíos are a native tribe of Mexico's remote Sonora desert, a rugged land of mountains, canyons, plains, and the all-important river. It is a land perhaps best known to botanists through Howard S. Gentry's *Rio Mayo Plants* (1942) and *Gentry's Rio Mayo Plants*, by P.S. Martin, Yetman, et al. (1998.) Yetman journeyed there again to study the plants and the ways that the native use the plants. Actually, by showing an interest in the plants, he became acquainted with the people and their lives so that his book is more of an anthropological study than a botanical one. Nevertheless plants figure predominantly, though it is in no way an attempt to update the earlier works. Rather, Yetman concentrates on the usage (food, medicine, lumber, etc.) with an introductory "plant primer" of nine unusual plants. He culminates his findings with a list of plants, the "ethnoflora" of the Guarijíos.—*Joann Karges, Botanical Research Institute of Texas, Fort Worth, TX, U.S.A.*

DAVID YETMAN and THOMAS R. VAN DEVENDER. 2002. **Mayo Ethnobotany: Land, History, and Traditional Knowledge in Northwest Mexico.** (ISBN 0-520-22721-2, hbk.). University of California Press, Berkeley, CA. U.S.A. (Orders: California Princeton Fulfillment Services, 609-883-1759; Fax 609-883-7413) $48.00 hbk. 359 pp., numerous black and white photographs.

In more than fifty trips of four to ten days between the early 1990s and 2000 the authors visited the Mayos of Sonora and Sinaloa, studying their land, their customs, and especially their use of plants. These are people who for the most part live off the land and so incorporate most of the plants in one way or another in their daily living. After a comprehensive explanation of the of the geography and topography of the land and the ethnography of the Mayos, the authors describe eight plants that are most important to the Mayos, plants that "make the Mayos Mayos." Following is a list of the plants of the areas, arranged by family, and providing the Mayo and Spanish names as well as the binomial. The authors describe the growing characteristics of each plant and cite its uses—some vitally important (construction, food, medicine) and some trivial (such as kindling or a children's seed spitting game).

With this work, Yetman and Van Devender have contributed another in their growing body of publications that lead to an understanding of the Mayos and their culture as it relates to plants—*Joann Karges, Botanical Research Institute of Texas, Fort Worth, TX, U.S.A.*

A SYNOPSIS AND NOMENCLATOR OF THE GENUS *PARATHESIS* (MYRSINACEAE)

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ABSTRACT

A new infrageneric classification for the genus *Parathesis* is proposed. The genus is divided into two subgenera, *Parathesis* subg. *Laterales* Ricketson & Pipoly, and subg. *Parathesis*. *Parathesis* subgenus *Laterales* is further divided into sections *Calophyllae* Ricketson & Pipoly, and *Laterales* Ricketson & Pipoly. *Parathesis* subg. *Parathesis* is also further divided into sections *Cubanae* Ricketson & Pipoly, *Parathesis*, and *Versatiles* Ricketson & Pipoly. All 95 species are listed in their respective sections.

RESUMEN

Se propone una nueva clasificación infragenérica para el género *Parathesis*. Se divide el género en dos subgéneros, *Parathesis* subg. *Laterales* Ricketson & Pipoly, y subg. *Parathesis*. Se divide el *Parathesis* subgénero *Laterales* en secciones: *Laterales* Ricketson & Pipoly, y *Calophyllae* Rickeston & Pipoly. Se divide *Parathesis* subg. *Parathesis* en secciones, *Cubanae* Ricketson & Pipoly, *Parathesis* y *Versatiles* Ricketson & Pipoly. Se enumeran todas las 95 especies del género en sus secciones respectivas.

INTRODUCTION

The genus *Parathesis* (A.DC.) Hook. f. was first described as a section of *Ardisia* Sw. by Alphonse de Candolle (1844) and included five species: *Ardisia cubana* A. DC. (*P. cubana* (A. DC.) Molinet & M. Gómez), *A. crenulata* Vent. (*P. crenulata* (Vent.) Hook. f. ex Hemsl.), *A. serrulata* Sw. (*P. serrulata* (Sw.) Mez), *A. lateriflora* Sw. (= *Stylogyne lateriflora* (Sw.) Mez) and *A. lepidota* Kunth. (= *Geissanthus lepidotus* (Kunth) Mez). *Parathesis* was elevated to the generic level by J.D. Hooker (1876).

In the first in-depth study of the genus, Carl Mez (1902) listed 20 species of *Parathesis*, including seven new species. However, it wasn't until C.L. Lundell (1966) published his monograph on the genus *Parathesis* that a usable classification was developed. Lundell listed 71 species divided into two "Sections" and 23 "Series". Admittedly Lundell stated (1966: p. 8) that his infrageneric classification was "designed to expedite the use of the general key," and therefore comprises a numerical listing rather than a formal classification.

Since Lundell's monograph was published, numerous species have been described, usually with no refernece to Lundell's classification system. Currently, we recognize approximately 150 taxa of *Parathesis*, 95 at the rank of species. Although Lundell's system is helpful, it is far too large and cumbersome to

be useful. In preparation for our treatment of the genus *Parathesis* for *Flora Mesoamericana*, a new infrageneric classification system was needed, which is formalized herewith. The species listed reflect our current understanding of the genus. Complete synonymies will appear in the *Flora Mesoamericana* and *Flora Neotropica*.

TAXONOMIC TREATMENT

Parathesis (A. DC.) Hook. f. in Benth. & Hook. f., Gen. pl. 2:645. 1876. *Ardisia* sect. *Parathesis* A. DC., Prodr. 8:120. 1844. TYPE: *Parathesis serrulata* (Sw.) Mez.

Terrestrial polyaxial shrubs and trees. Young branchlets frequently ferrugineous-tomentose with stellate or dendroid trichomes, often glabrescent. Leaves monomorphic, alternate, the blades usually pubescent on the lower surface, the trichomes stellate or dendroid, often appressed and bizonal, often early glabrescent, or glabrous, usually paler beneath; costa and primary lateral veins usually elevated beneath, smooth or impressed above; margins entire, crenulate, dentate or serrate; petioles marginate or canaliculate. Inflorescences terminal or lateral, paniculate and pyramidal, the branches umbellate, corymbose or subcorymbose-racemose; pedicels accrescent. Flowers bisexual, (4-or)-5 (or-6)-merous; calyx connate at the base, open in bud, usually glandular tomentulose and papillose; corolla rotate, valvate, usually narrowly lanceolate, white to pink, usually tomentulose outside, glandular papillose-tomentose inside at least along margins and apically, connate basally to form a tube; stamens included, inserted near the base of corolla tube, the filaments well developed, slender to stout, usually connate basally to form a tube, the bright yellow anthers erect or versatile, usually dorsifixed above base, dehiscent by introrse slits or apical pores, sagittate, lanceolate to ovate, acute, mucronate, apiculate or obtuse at the apex, dorsally punctate or epunctate; pistil obturbinate, the ovary ovoid or subglobose, the style long and slender, the stigma punctiform, ovules few to numerous, usually uniseriate, sometimes biseriate or rarely pluriseriate on the placenta. Fruits drupaceous, 1-seeded, usually depressed-globose, the endocarp crustaceous, the embryo cylindric, transverse.

A genus of ca. 95 species ranging from northern Mexico to Panama, the Carribean and throughout the Andes from Venezuela to Bolivia. Members of the genus occur from coastal mangroves to elfin forest formations at high elevations. The genus is diagnosed by the unique glandular papillae of the calyx and corolla lobes, and the bright yellow anthers.

KEY TO THE SUBGENERA AND SECTIONS OF *PARATHESIS*

1. Inflorescences lateral, or terminal and lateral _____ **Subg. Laterales**
   2. Tomentum of branchlets and the undersurface of the leaves fine, mostly stellate and usually closely appressed, sometimes sub-appressed and rather loose, often glabrescent _____ **Sect. Laterales**

2. Tomentum of branchlets and undersurface of the leaves usually coarse and conspicuous and of distinct reddish trichomes, the trichomes dendroid and sessile or stipitate, or the trichomes stellate with erect and spreading rays, the stellate trichomes either sessile, subsessile, or stipitate _____ **Sect. Calophyllae**

1. Inflorescences terminal, pyramidal-paniculate _____ **Subg. Parathesis**

3. Anthers versatile, or tardily versatile, with longitudinal slits, dorsifixed at or about the middle; filaments usually longer than the anthers _____ **Sect. Versatiles**

3. Anthers erect, with longitudinal slits and/or subterminal pores, usually dorsifixed near the base, never versatile; filaments shorter than the anthers, often one-half as long.

4. Tomentum of branchlets and abaxial leaf surface fine, mostly sessile or subsessile stellate and usually closely appressed, sometimes sub-appressed and rather loose, often glabrescent _____ **Sect. Cubanae**

4. Tomentum of branchlets and undersurface of the leaves usually coarse and conspicuous and of distinct reddish trichomes, the trichomes dendroid, sessile or stipitate, or the trichomes sessile, subsessile or stipitate stellate with erect and spreading rays, usually persistent. _____ **Sect. Parathesis**

Parathesis (A. DC.) Hook. f. in Benth. & Hook. f. subg. **Laterales** Ricketson & Pipoly, subg. nov. TYPE (here designated): *Parathesis adenanthera* (Miq.) Hook. f. ex Mez.

Hoc subgenus a subgenere Parathese inflorescentiis lateralibus (axillaribus) vel terminalibus et lateralibus perfacile separabilis.

Inflorescences lateral (axillary), or terminal and lateral (axillary).

Parathesis subg. *Laterales* as circumscribed here consists of two sections (sect. *Calophyllae* and sect. *Laterales*) and includes 42 species.

Parathesis subg. **Laterales** Ricketson & Pipoly sect. **Calophyllae** Ricketson & Pipoly, sect. nov. TYPE: *Parathesis calophylla* Lundell.

Sectio haec a sectione Lateralibus tomento grosso conspicuo arque persistente statim distat.

Inflorescences axillary, or terminal and axillary; tomentum of branchlets and undersurface of the leaves usually coarse and conspicuous and of distinct reddish trichomes, the trichomes dendroid and sessile or stipitate, or the trichomes stellate with erect and spreading rays, the stellate trichomes either sessile, subsessile, or stipitate.

Parathesis subg. *Lateralis* sect. *Calophyllae* contains 9 species:

Parathesis calophylla Donn. Sm.
P. oerstediana Mez
P. pipolyana Ricketson
P. pleurobotryosa Donn. Sm.
P. pseudocalophylla Ricketson & Pipoly
P. reflexa Brandegee
P. schultesii Lundell
P. travisae Lundell
P. vestita Lundell

Parathesis subg. **Laterales** Ricketson & Pipoly sect. **Laterales** Ricketson & Pipoly, sect. nov. TYPE: *Parathesis adenanthera* (Miq.) Hook. f. ex Mez.

Sectio haec sectionem Laterali inflorescentiis lateralibus vel lateralibus et terminalibus, tomentio subtiliter adpresso vel subadpresso atque plerumque glabrescentes statim distat.

Inflorescences lateral, or terminal and lateral; tomentum of branchlets and undersurface of leaves fine, mostly stellate and usually closely appressed, sometimes sub-appressed and rather loose, often glabrescent.

Parathesis subg. *Laterales* sect. *Laterales* contains 33 species:

Parathesis adenanthera (Miq.) Hook. f. ex Mez
P. angustifolia Lundell
P. aurantiaca Lundell
P. calzadae Lundell
P. candolleana Mez
P. cintalapana Lundell
P. conzattii (S.F. Blake) Lundell
P. cuspidata Lundell
P. glaberrima Lundell
P. glabra Donn. Sm.
P. gracilis Lundell
P. leptopa Lundell
P. macrantha Lundell
P. macronema Bullock
P. melanosticta (Schltdl.) Hemsl.
P. minutiflora Lundell
P. montana Lundell
P. moritziana Mez
P. multiflora Lundell
P. psychotrioides Lundell
P. rekoi Standl.
P. seibertii Lundell
P. skutchii Lundell
P. subulata Lundell
P. tartarea Lundell
P. tenuis Standl.
P. tomentosa Lundell
P. venezuelana Mez
P. villosa Lundell
P. vulgata Lundell
P. wendtii Lundell
P. rekoi Standl.
P. seibertii Lundell

Parathesis (A. DC.) Hook. f. subg. **Parathesis**.

Inflorescences terminal, pyramidal-paniculate

Parathesis subg. *Parathesis* as circumscribed here consists of three sections (sect. *Cubanae*, sect. *Parathesis* and sect. *Versatiles*) and includes 53 species.

Parathesis subg. **Parathesis** sect. **Cubanae** Ricketson & Pipoly, sect. nov. TYPE: *Parathesis cubana* (A. DC.) Molinet & M. Gómez.

Sectio haec quoad antheras erectas dorsifixas longitudinaliter vel subapicaliter dehiscentes necnon filamenta antheris breviora, sect. Parathesi valde affnis, sed ab ea foliis ramulisque subtiliter et adpresse- (nec grosse et erecte) tomentosis perclare distinguitur.

Inflorescence terminal, pyramidal-paniculate; anthers erect, with longitudinal slits and/or subterminal pores, usually dorsifixed near base, never versatile; filaments shorter than the anthers, usually one-half as long; tomentum of branchlets and undersurface of leaves fine, mostly stellate and usually closely appressed, sometimes subappressed and rather loose, often glabrescent.

Parathesis subg. *Parathesis* sect. *Cubanae* contains 26 species:

Parathesis agostiniana Lundell
P. bracteolata Lundell
P. breedlovei Lundell
P. crassiramea Lundell
P. crenulata (Vent.) Hook. f. ex Hemsl.
P. cubana (A. DC.) Molinet & M. Gómez
P. donnellsmithii Mez
P. emarginata Mez

P. ferruginea Lundell
P. lanceolata Brandegee
P. laxa Lundell
P. lenticellata Lundell
P. mexicana Lundell
P. microcalyx Donn. Sm.
P. obtusa Lundell
P. parvissima Lundell
P. perpunctata Lundell
P. pseudocrassiramea Ricketson & Pipoly
P. reticulata Lundell
P. rosea Lundell
P. rothschuhiana Mez
P. sinuata (Lundell) Ricketson & Pipoly
P. subcoriacea Lundell
P. tetramera Bullock
P. williamsii Lundell
P. zuliana Lundell

Parathesis subg. **Parathesis** sect. **Parathesis**

Inflorescences terminal, pyramidal-paniculate; anthers erect, with longitudinal slits and/or subterminal pores, usually dorsifixed near base, never versatile; filaments shorter than anthers, usually one-half as long; tomentum of branchlets and undersurface of leaves usually coarse and conspicuous and of distinct reddish trichomes, the trichomes dendroid and sessile or stipitate, or the trichomes stellate with erect and spreading rays, the stellate trichomes either sessile, subsessile, or stipitate.

Parathesis subg. *Parathesis* sect. *Parathesis* contains 15 species:

Parathesis acostensis J.F. Morales
P. aeruginosa Standl.
P. amazonica Mez
P. chiapensis Fernald
P. columnaris Lundell
P. eggersiana Mez
P. fusca (Oerst.) Mez
P. kochii Lundell
P. neei Lundell
P. prionophylla Standl.
P. rufa Lundell
P. serrulata (Sw.) Mez
P. sessilifolia Donn. Sm.
P. tenorioi Lundell
P. villalobosii Lundell

Parathesis subg. **Parathesis** sect. **Versatiles** Ricketson & Pipoly, sect. nov. TYPE: *Parathesis trichogyne* Hemsl.

Sectio haec inter alias antheris versatilis longitudinaliter deshiscentibus et dorsifixis, filamentis antheris longioribus statim diagnoscenda.

Inflorescences terminal, pyramidal-paniculate; anthers versatile, or tardily versatile, with longitudinal slits, dorsifixed at or about the middle; filaments usually longer than the anther.

Parathesis subg. *Parathesis* sect. *Versatiles* contains 12 species:

Parathesis acuminata Lundell
P. amplifolia Lundell
P. cartagoana Lundell
P. costaricensis Ricketson
P. croatii Lundell
P. glendae Ricketson
P. longipedicellata Ricketson
P. palaciosii Pipoly
P. panamensis Lundell
P. papillosa Lundell
P. pyramidalis Lundell
P. trichogyne Hemsl.

EXCLUDED TAXA

Parathesis acutissima Cuatrec. = *Hymenandra acutissima* (Cuatrec.) Pipoly & Ricketson
Parathesis micranthera Donn. Sm. = *Gentlea micranthera* (Donn. Sm.) Lundell
Parathesis viridis Lundell = *Stylogyne viridis* (Lundell) Ricketson & Pipoly

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A NEW SPECIES OF *STYLOGYNE* (MYRSINACEAE) FROM DARIÉN, PANAMA

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ABSTRACT

Preparation of a taxonomic treatment of the Myrsinaceae for the *Flora Mesoamericana* project resulted in the discovery of a new species, *Stylogyne pucuroensis* Ricketson & Pipoly, which is described and illustrated. Its closest relationship is with *S. ardisioides* A. DC. *Stylogyne glomeruliflora* is removed from the project area.

RESUMEN

Al preparar un tratamiento taxonómico de la familia Myrsinaceae para Flora Mesoamericana, se descubrió una especie nueva para la ciencia, *Stylogyne pucuroensis* Ricketson & Pipoly. Se describe, se ilustra y se discute el parentezco de la nueva especie. Se elimina la especie *Stylogyne glomeruliflora* como registro para Mesoamerica como resultado del estudio.

Stylogyne pucuroensis Ricketson & Pipoly, sp. nov. (**Fig. 1**). TYPE. PANAMA. DARIÉN: Parque Nacional del Darién, ridge between N & S branches of Río Pucuro, in forest N of old village of Tacarcuna, ca. 18 km E of Pucuro, 077° 16' W, 08° 05' N, 600–800 m, 24 Oct 1987 (fr.), *B. Hammel, G. de Nevers, H. Cuadros & H. Herrera 16469* (HOLOTYPE: MO; ISOTYPES: FTG, LL, PMA).

Quoad inflorescentias laterales petiolos aequantes necnon flores 5-partitos *S. ardisioideo* valde arcte affinis, sed ab ea laminis ellipticis (non oblongis), petiolis marginatis (non canaliculatis) sepalis ovatis vel oblongis (non subdeltatis vel deltatis) 1.3–1.5 (nec 1.6–2.0) mm longis atro- (nec pellucido-) punctatis, denique fructu stylo persistente (non caduco) perfacile recognoscitur.

Shrubs to 3.5 m tall. ***Branchlets*** slender, terete, 1–3 mm in diam., glabrous. ***Leaves:*** with blades membranous, elliptic, 8.8–14.6 cm long, 2.8–5.6 cm wide, apically acuminate, with an acumen 1–1.6 cm long, basally acute, decurrent on the petiole, conspicuously and prominently punctate and punctate-lineate, glabrous, the midrib impressed above, prominently raised below, the secondary veins 37–47 pairs, inconspicuous above and below, the margins entire, flat; petioles slender, marginate, 0.5–1 cm long, glabrous. ***Inflorescences*** lateral, appearing paniculate, 3–5-racemose branches from a common fascicle, 0.5–1 cm long, 1–1.5 cm wide, shorter than the leaves, the rachis glabrous, the branches 3–7-flowered racemes; peduncles nearly obsolete, glabrous; inflorescence bracts unknown; floral bracts persistent, chartaceous, ovate, 0.5–0.6 mm long, 0.5–0.8 mm wide, apically acute, prominently punctate and punctate-lineate, glabrous, the veins inconspicuous, the margins entire; pedicels slender, terete, 2.3–3.2 mm long,



FIG. 1. *Stylogyne pucuroensis* Ricketson & Pipoly. **A.** Flowering branch. **B.** Fruiting inflorescence. Drawn from holotype, *B. Hammel et al. 16469* (MO).

prominently punctate and punctate-lineate, glabrous. ***Flowers*** 5-merous; calyx membranous, the sepals ovate to oblong, 1.3–1.5 mm long, 0.7–0.9 mm wide, apically acute, prominently punctate and punctate-lineate, glabrous, the margins entire; corolla, stamens and pistil unknown. ***Fruits*** red, globose, 4.5–5.3 mm in diam., conspicuously and prominently punctate and punctate-lineate, glabrous, conspicuously costate, the style base persistent.

Distribution.—Known only from the type collection in the Parque Nacional del Darién, adjacent to the lower slopes of Cerro Tacarcuna, in Darién, Panama, growing between 600–800 m elevation.

Ecology and conservation status.—*Stylogyne pucuroensis* occurs in premontane pluvial forest. Because it occurs in a remote area of the Darién near the Panama-Colombia border and within the National park, this species should not be considered threatened at this time.

Etymology.—The specific epithet comes from its locality, near the Río Pucuro.

Because of its lateral inflorescences equal to the petioles and 5-merous flowers, *Stylogyne pucuroensis* is most closely related to *S. ardisioides*. However, *S. pucuroensis* has elliptic (not oblong) leaf blades, marginate (not canaliculate) petioles, ovate to oblong (not subdeltate to deltate) sepals 1.3–1.5 (not 1.6–2) mm long with black (not pellucid) punctations. Finally in *S. pucuroensis* the persistent (not caducous) style on the fruit permit easy recognition.

In our previous paper (Ricketson & Pipoly 1997) this collection was confused with *Stylogyne glomeruliflora* Cuatrec., a species from the Chocó Floristic Province. However, further studies of the genus *Stylogyne* have shown that *S. glomeruliflora* is a member of a small group of taxa with 4-merous flowers, while *S. pucuroensis* has a 5-merous flower. Although the small lateral inflorescences are similar, a number of taxa possess this character, including *S. darienensis*, which has much longer, racemose branches. *Stylogyne glomeruliflora* should not be considered a member of either the Panamanian or Mesoamerican floras. We therefore provide a revised key to the species of *Stylogyne* in Mesoamerica.

KEY TO MESOAMERICAN SPECIES OF *STYLOGYNE*

1. Leaf blades bullate, pubescent, the margins crenate _____ **Stylogyne hayesii** Mez
1. Leaf blades smooth, glabrous, the margins entire.
   2. Inflorescences lateral, sessile or subsessile corymbose or racemose, 3–7-racemes from a common fascicle.
      3. Inflorescences elongated racemes or corymbs, 2–4.5 cm long; pedicels 3–3.5 mm; anthers strictly longitudinally dehiscent; fruits 5.5–6.5 mm in diam. _____ **Stylogyne darienensis** Lundell
      3. Inflorescences short racemes, 0.5–1 cm long; pedicels 0.5–2 mm; anthers dehiscent by pores opening into longitudinal slits; fruits 4–5 mm in diam. _____ **Stylogyne pucuroensis** Ricketson & Pipoly

2. Inflorescences terminal and/or lateral, paniculate _____ **Stylogyne turbacensis** (Kunth) Mez

4. Leaf blades obovate to oblanceolate, subcoriaceous, the punctations conspicuous above; inflorescences pyramidal-paniculate, mostly terminal, or occasionally terminal with few reduced lateral inflorescences _____ **Stylogyne turbacensis** subsp. **turbacensis**

4. Leaf blades elliptic to oblong, coriaceous, the punctations inconspicuous from above; inflorescences columnar-paniculate, mostly lateral or rarely lateral and terminal or pseudoterminal _____ **Stylogyne turbacensis** subsp. **laevis** (Oerst.) Ricketson & Pipoly

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PTEROCERAS MONSOONIAE (ORCHIDACEAE), A NEW SPECIES FROM INDIA

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ABSTRACT

A new species of the South East Asian Genus *Pteroceras* Hassk. is described, illustrated and compared to its closest relative *Pteroceras johorense*.

RESUMEN

Se describe una nueva especie del género *Pteroceras* Hassk. del sureste de Ásia, se ilustra y se compara con su pariente más próximo *Pteroceras johorense*.

INTRODUCTION

Pteroceras Hassk. is reported to have 19 species, mostly inhabited in the warm humid regions of Southeast Asia, and is best represented in Borneo with 10 species (Pedersen 1993). From Peninsular India, only one species, *Pteroceras leopardinum* (Parish & Reichb. f.) Seidenf. & Smitin., is reported. During our recent explorations in the Parambikulam Wildlife Sanctuary of Kerala interesting specimens of *Pteroceras* were collected. The specimens were found to differ from the South Indian species. Following the monograph of the genus (Pedersen 1993) the specimens show similarities with the little known *Pteroceras johorense* (Holttum) Holttum that seems to be endemic to Johor in Peninsular Malesia. However, they differ in the leaf form and size; texture, form and size of the peduncle, size of the bracts and floral parts; structure of labellum and pollinia (Table 1). Pedersen (1993) recognized four main types of inflorescences in the genus. Our species agrees with *Pteroceras asperatum* (Schltr.) P.F. Hunt, *P. hirsutum* (Hook. f.) Holttum, *P. johorense* (Holttum) Holttum, *P. muriculatum* (Reichb. f.) P.F. Hunt, *P. philippinense* (Ames) Garay and *P. spathibrachiatum* (J.J. Smith) Garay by having a muricate or prickly (sub)terete rachis without any keel or wings. Drawings of our material were sent to Pedersen who supported our view that it should be described and illustrated as a new species.

Pteroceras monsooniae Sasidharan & Sujanapal, sp. nov. (**Fig. 1**). TYPE: INDIA. KERALA. PALAKKAD DISTRICT: Parambikulam Wildlife Sanctuary, 10°32'226" N, 76°86'552" E, 1180m, 28 May 2000, *P Sujanapal KFRI 30407* (HOLOTYPE: KFRI; ISOTYPES: BRIT, CALI, MH, TBGT)

Pterocerati johorensi similis in rhachide aculeata tereti et perianthio oblong-ovato acuto vel rotundato, sed folii apice latus facto bilobato, pedunculo crasso brevi prominente aculeato, floribus

TABLE 1. Comparison of *Pteroceras monsooniae* with *P. johorense* (Holttum) Holttum.

Character	Pteroceras johorense[1]	Pteroceras monsooniae
Leaves	ca. 5 on a flowering shoot linear-lanceolate, 5–8 × 1–1.5 cm, apex narrowed, obtuse or unequally bilobed, lobes very small	ca. 4 on a flowering shoot linear or elliptic-lanceolate, to 4–8 × 1–2 cm, apex broad, unequally bilobed, lobes broad and rounded
Roots	0.6–1 mm diameter	4–6 mm diameter
Inflorescence	to 3 per plant Erect, 3.7–4.1 cm long	2–7 per plant at right angles to the stem, 1–3 cm long
Flowers	2–8, arranged towards the apex of the raceme peduncle 0.4–0.6 mm diameter	2–4, equidistantly arranged in the raceme peduncle 2–4 mm diameter
Bracts	ca. 1 × 1 mm, subtriangular, not embracing the peduncle base 6 mm broad hairy on abaxial side apex not spinulate	ca. 6 mm long, broadly ovate, embracing the peduncle, prickly on abaxial side apex spinulate
Floral parts	median sepal, 8.5–11 × 4.5–5 mm petals 8.3–10 × 4.6–5.2 mm spur without ridges anther ovate with an acute triangular apex, pollinia subspherical, 1–1.2 mm diameter	median sepal to 18 × 10 mm petals to 14 × 8 mm spur with two ridges Anther triangular with a caudate apex pollinia obovoid, 1.5–1.8 mm long, 1 mm broad

[1]Characters based on Pedersen's (1993) description. The description of *Pteroceras johorense* is rather poor due to the rarity of this little known species which is known from two collections only.

aequidistantibus, bractea magna aculeata apice spinuloso, calcare bi-porcato, polliniis obovoideis rima L-forma differt.

Epiphytic herb, stem to 2 cm tall, erect, unbranched. Leaves 4, distichously alternate, 4–8 × 1–2 cm, sessile, articulate, linear to elliptic-lanceolate, slightly wider towards the apex, unequally bilobed, lobes rounded; leaf sheaths imbricate, glabrous, covering the internodes. Inflorescences racemous, from the axils of older leaf sheaths, 2–7, unbranched, at right angles to the stem, 1–3 cm long; peduncle terete, ca. 4 mm diameter, gray, densely covered with soft brown prickles; bracts ca. 6 mm long, persistent, broadly ovate, spinulose at apex, prickly on abaxial side; base 6 mm wide, more or less sheathing the peduncle; flowers 2–4, sessile, spirally alternating (one open at a time). Sepals and petals free, spreading, sparsely prickly on abaxial side, grayish-white; median sepal ca. 1.8 × 1 cm, laterals adnate to the column foot, elliptic-obovate, apex acute; petals ca. 1.4 × 0.8 cm, oblong-obovate, base rounded, glabrous or slightly muricate on abaxial side. Labellum to 6 mm long, side lobes 4 × 3 mm, embracing the column before anthesis and spreading (open) after anthesis, apical part widened, apex obliquely rounded, midlobe small, with a porrect spur. Spur saccate, ca. 3 mm across and 2-toothed at mouth, apex rounded with 2 dorsal ridges,

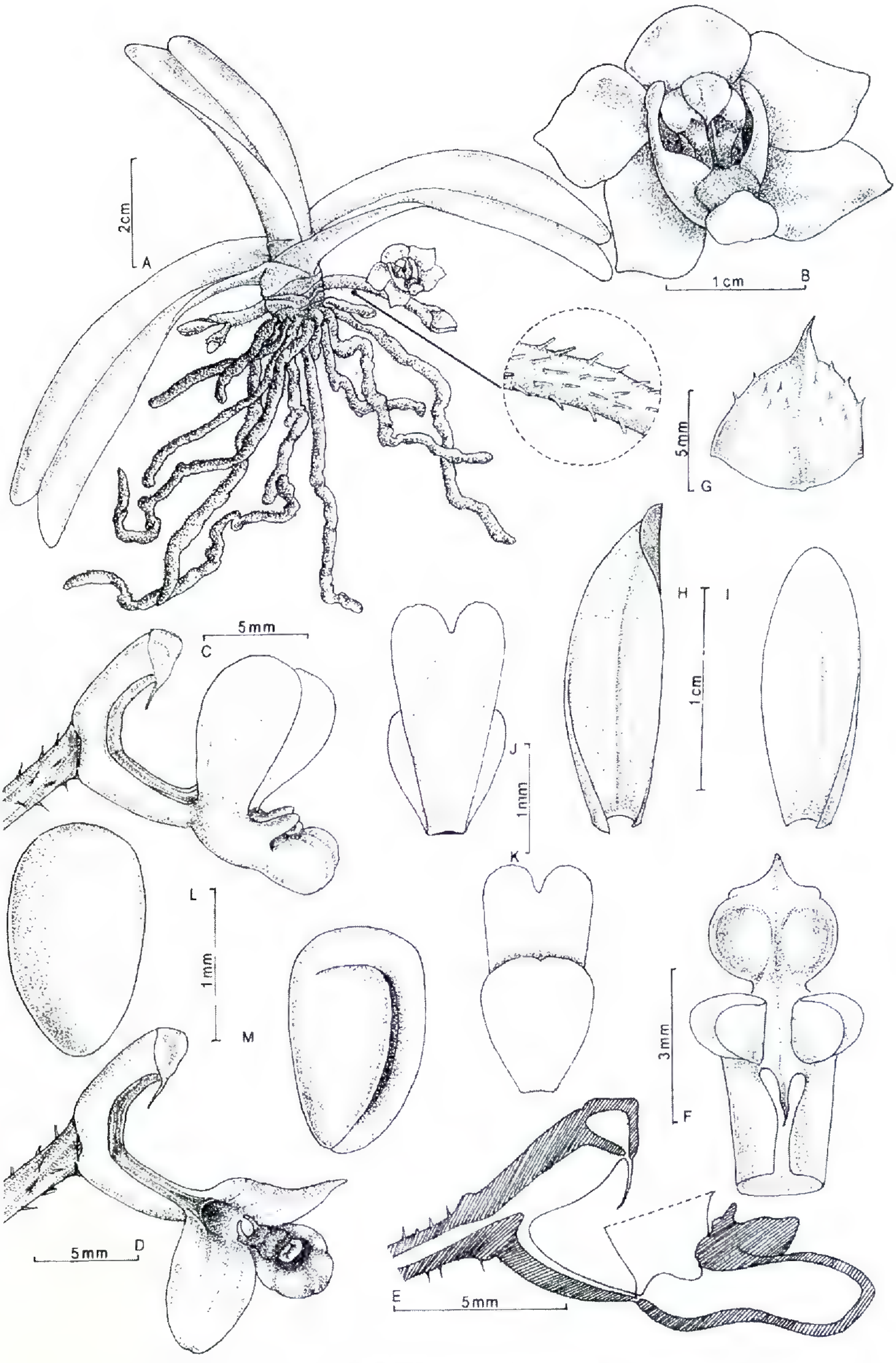


Fig. 1. *Pteroceras monsooniae* Sasidharan & Sujanapal. **A.** Habit; **B.** Flower; **C.** & **D.** Column with lip (dorsal and ventral view); **E.** Flower L.S. (sepals and petals removed); **F.** Column; **G.** Bract; **H.** Sepal; **I.** Petal; **J.** & **K.** Stipe with viscidium (dorsal and ventral view); **L. & M.** Pollinia.

lower ridge yellowish, ca. 2 mm; rostellum ca. 3 mm, deeply bifid 3 mm, clinandrium 3 mm diameter, apiculum 2 mm long. Anther terminal, triangular with a caudate apex, strongly incumbent, dehiscing ventrally, to form 2 flaps; pollinia 2, obovoid, 1.5–1.8 × 1 mm, deeply cleft, stipe ca. 2 mm long, narrowed towards the base, bilobed at apex, lobes rounded, viscidium obovate, to 1 mm long, broader than the stipe. Ovary ca. 1 cm, terete, twisted to the left, slightly 6-ribbed, sparsely echinate. Capsule ellipsoid, to 2.8 × 1.6 cm, 6-ribbed depressed at apex (Fig. 1).

Note.—The flower has a two-ridged spur with an yellowish neck (like the head of a honey bee) which attracts insects during anthesis. The flowers are ephemeral and withering after 8–10 hours. However, the floral parts continue to be attached to the ovary during the fruit development.

Flowering and Fruiting.—May–June, usually flowering with the onset of the southwest monsoon.

Etymology.—Specific epithet of the new taxon is based on the flowering season.

Distribution.—Known only from the type locality

Habitat.—This small monopodial epiphyte is growing ± 1100 m above sea level on trees like *Phyllanthus emblica* L. and *Syzygium cumini* (L.) Skeels along the ecotone area of grassland. Other common trees in the locality are *Cinnamomum sulphuratum* Nees, *Ficus tinctoria* Forst. f. ssp. *parasitica* (Koen. ex Willd.) Corner, *Xantolis tomentosa* (Roxb.) Rafin. var. *elengioides* (DC.) Vajra., etc. The locality constitutes a continuation of the Coimbatore plateau of Deccan which is subjected to high velocity of wind and humidity. Therefore the trees are mostly stunted and clothed with dense moss growth.

PARATYPE: **INDIA. Kerala. Palakkad district:** Parambikulam Wildlife Sanctuary, 10°32'226" N, 76°86'552" E, 1180 m, 19 May 2001 *Sujanapal KFRI 30596* (KFRI).

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SYMPLOCOS KOTHAYARENSIS (SYMPLOCACEAE), A NEW SPECIES FROM PENINSULAR INDIA

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ABSTRACT

A new species of Symplocaceae, *Symplocos kothayarensis* Sundaresan, Jothi, Rajkumar & Manickam from the Southern Western Ghats of Tamil Nadu, India is described and illustrated.

KEY WORDS: Symplocaceae, *Symplocos kothayarensis*, Tamil Nadu, India.

RESUMEN

Se describe y se ilustra una especie nueva de Symplocaceae, *Symplocos kothayarensis* Sundaresan, Jothi, Rajkumar & Manickam del suroeste de Ghats de Tamil Nadu, India.

INTRODUCTION

The family Symplocaceae comprises four genera (fide Index Nominum Genericorum; ex: Bobu, Dicalix, Cordyloblaste) and 500 species distributed in the tropical and subtropical regions, except Africa (Ahmedullah & Nayar 1986). They occur in the eastern parts of the Old World, reaching from Bombay in the West to Fiji in the east and from Manchuria in the north to New South Wales and Lord Howe Island in the south. In the New World the species occur from the state of Washington to southern Brazil (Nooteboom 1981).

The genus *Symplocos* Jacq. is represented in India by ca. 45 species. Among these, 13 species and one variety are endemic to peninsular India (Ahmedullah & Nayar 1986). In Tamil Nadu alone the genus *Symplocos* is represented by 10 species and six subspecies (Gopalan 1987).

The southern section of the Western Ghats in India is by far the richest floristic area with a concentration of endemic taxa (Ahmedullah & Nayar 1986). The Tirunelveli hills which include the "Agasthiyamalai' hills, is a remarkable

micro endemic center and one of the hot spots of the Indian flora (Nayar 1996) and attested by IUCN as CPD CITE IS7 (Davis et al. 1994).

During the preparation of the family Symplocaceae for the flora of Tirunelveli hills, one specimen was observed with striking differences belonging to the genus *Symplocos* Jacq. On critical examination, it was found to be a new species, and is described and illustrated here.

Symplocos kothayarensis Sundaresan, Jothi, Rajkumar & Manickam, sp. nov. (**Fig. 1**). TYPE: INDIA. TAMIL NADU. TIRUNELVELI HILLS. KANYAKUMARI DT.: Kothayar near Muthukuzhivayal, 1450 m, 12 Mar 1998, *Sundaresan 14968* (HOLOTYPE: XCH; ISOTYPE: MH).

Symplocos pulchrae arte affinis, sed foliis obovato-oblongis, obtusis; racemes curtioribus; disco glabrato et stylo ad basim glabrato differt.

Small trees to 2(–3)m tall; branchlets fulvous tawny hairy. Leaves simple, alternate, coriaceous, oblong-obovate, 6–9 × 2–4 cm, entire or serrate or half serrate at margin, the nerves ca. 6 pairs, faintly prominent, glabrous above, sparsely hairy beneath, the apex obtuse, emarginate, base acute-subobtuse; petioles ca. 2mm long, thick, bristly tawny hairy. Fowers ca. 15 in condensed axillary racemes, ca. 1cm long; bracts ovate, ca. 2.3 × 1.2mm long, obtuse at apex, densely villous without, glabrous within, persistent; flowers sessile or shortly pedicellate. Calyx tube ca. 1 mm long, with long appressed hairs; lobes 5, ovate, obtuse or subacute at apex, appressed hairy without, glabrous within. Corolla white, lobes 5, ovate-elliptic, apex subacute-obtuse, ca. 3.2 mm long. Stamens ca. 30, connate at the base, filaments free, ca. 2–2.5mm long; anthers 2-celled, ca. 0.5 mm long, Ovary ca. 1.3 mm long, hairy, 3-locular; ovules 2–3; styles stout, ca. 3mm long; stigma capitate; disc 5-lobed, glandular, glabrous. Fruits not seen.

Distribution.—*Symplocos kothayarensis* is endemic to the southern part of Western Ghats, Tamil Nadu, India and is known only from the type locality, Kothayar hills of Tirunelveli hills near Muthukuzhivayal in Kanyakumari District of Tamil Nadu.

Ecology and phenology.—This species grows at 1450 m elevation in the dense evergreen forests along with the species like *Cullenia exarillata* Robyns, *Elaeocarpus serratus* L., *Mallotus philippensis* (Lam.) Muell.-Arg. var. *philippensis*, *Artocarpus heterophyllus* Lam. *Symplocos cochinchinensis* (Lour.) Moore subsp. *laurina* (Retz.) Nooteb. etc....; flowering late February to April.

Etymology.—The species is named after its type locality.

Symplocos kothayarensis is closely allied to *S. pulchra* Wight but it differs in the obovate-oblong, obtuse leaves, short racemes, and glabrous disc and style base.

IDENTIFICATION KEY TO *SYMPLOCOS KOTHAYARENSIS*

1. Diffuse shrubs. Leaves membranous, oblong-lanceolate, apex long acuminate, base rounded or subcordate. Racemes > 2 cm. Disc and style base hairy _____ **S. pulchra**
1. Small trees, Leaves coriaceous, obovate-oblong, apex obtuse, emarginate, base acute subobtuse. Racemes < 1 cm. Disc and style base glabrous _____ **S. kothayarensis**

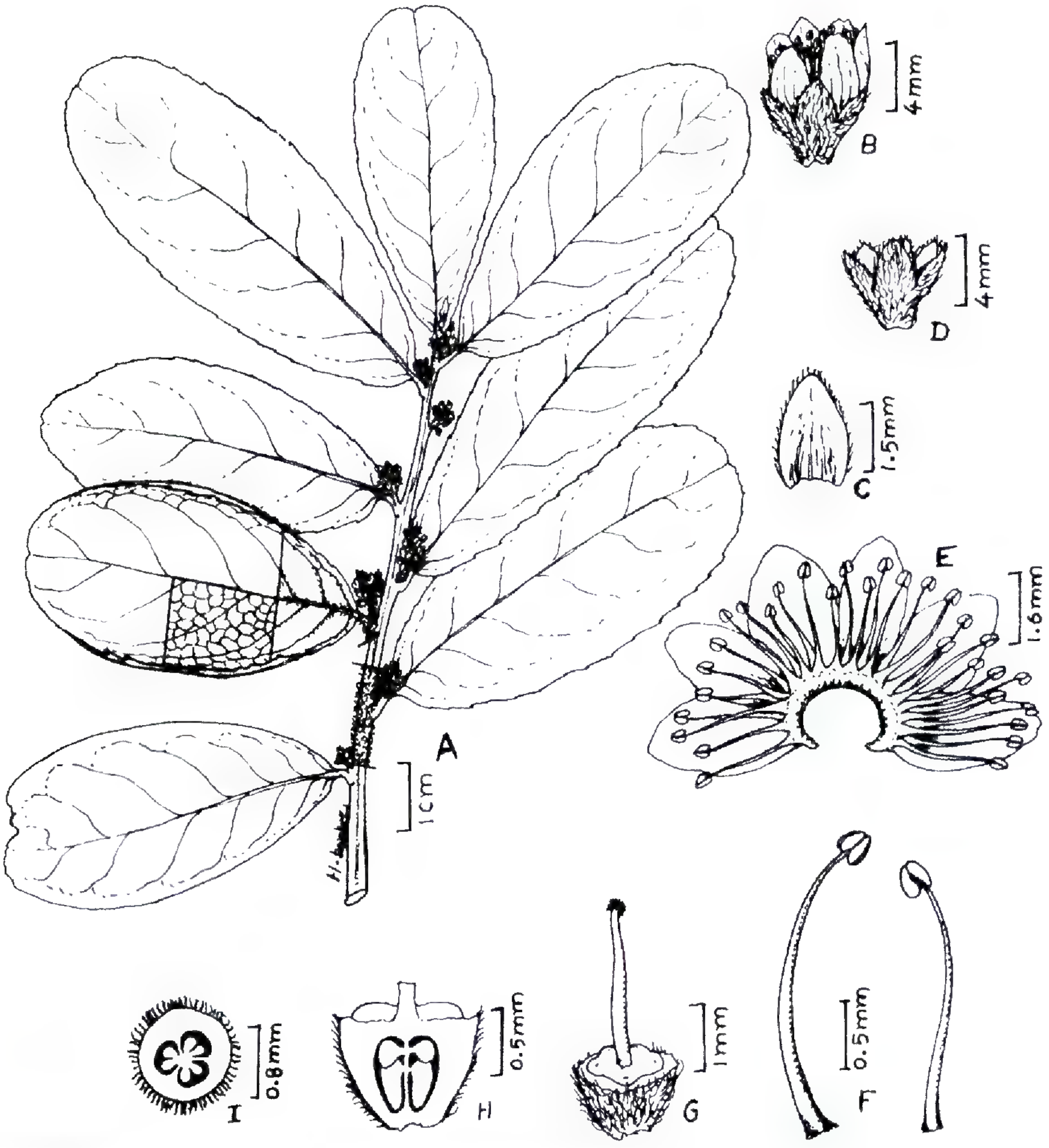


FIG. 1. *Symplocos kothayarensis*. **A.** Flowering shoot. **B.** Flowers. **C.** Bracts. **D.** Calyx. **E.** Corolla split open. **F.** Stamens. **G.** pistil with disc. **H.** Ovary (long. section). **I.** Ovary (cross section) drawn from the type by H. Sankar.

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SINOPSIS DEL GÉNERO *MELIOSMA* (SABIACEAE) EN COSTA RICA Y PANAMÁ, CON TRES NUEVAS ESPECIES

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RESUMEN

Se presenta una sinopsis del género *Meliosma* (Sabiaceae) en Costa Rica y Panamá. Tres nuevas especies, *Meliosma chiriquensis*, *M. clandestina* y *M. depressiva* son descritas e ilustradas.

ABSTRACT

A synopsis of the Costa Rican and Panamanian species of *Meliosma* (Sabiaceae) is presented here. *Meliosma chiriquensis*, *M. clandestina*, and *M. depressiva* are described and illustrated and their relationships are discussed.

El género *Meliosma* (Sabiaceae) es un género respresentado por cerca de 15 especies en los trópicos asiáticos y 40 en el neotrópico (Gentry 1980). Todas las especies estan restringidas a zonas de bosque húmedo, donde se pueden reconocer fácilmente por sus hojas simples alternas a subopuestas o raramente subverticiladas, con pecíolos pulvinulados y por sus frutos, con secreción gomosa al cortarse cuando maduros, persistentes por largo tiempo en el árbol, inclusive hasta 1 año despúes de madurar.

En vista de la ausencia de trabajos taxonómicos monográficos recientes para la región de Mesoamérica y la presencia de varias especies aún no descritas encontradas en el proceso de la elaboración del tratamiento de Sabiaceae para el Manual de las Plantas de Costa Rica, una sinopsis del género *Meliosma* en Costa Rica y Panamá se presenta a continuación, incluyendo distribución y datos fenológicos; en aquellos casos de especies recientemente registradas, nuevos reportes o de complejos taxonómicos de especies afines, se incluyen los especímenes examinados más representativos. En virtud que los frutos en este género persisten durante largo tiempo en el árbol despúes de producidos y las colecciones no clarifican la presencia de frutos maduros o ya secos desde hace largo tiempo, he decidido no incluir datos sobre la fructificación en las descripciones.

CLAVE PARA LAS ESPECIES DE *MELIOSMA* EN COSTA RICA Y PANAMÁ

1. Hojas largamente pecioladas, la mayoría de los pecíolos más de 4.5 cm largo (rara vez 4 cm en hojas muy jovenes).
   2. Hojas cordadas basalmente; sépalos 1.5 mm largo _____ **M. cordata**

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2. Hojas cuneadas, obtusas a redondeadas basalmente; sépalos 0.5–1 mm largo.
   3. Hojas densamente puberulentas en el envés, más evidente a lo largo de los nervios; flores rojo-vino a rojo-marrón; bosques en Cordilleras 1600–2000 m _____ **M. depressiva**
   3. Hojas glabras o glabrecentes en el envés; flores anaranjado crema a anaranjadas; bosques en llanuras húmedas y filas costeras bajo los 600 (1000) m _____ **M. allenii**
1. Hojas subsésiles a muy cortamente pecioladas, pecíolos usualmente menos de 4 cm largo.
   4. Hojas densa a moderadamente puberulentas en el envés, la pubescencia diminuta, pero regularmente esparcida por toda la lámina.
      5. Láminas levemente cordadas basalmente _____ **M. subcordata**
      5. Láminas cuneadas a obtusas basalmente.
         6. Pecíolos menos de 9 mm _____ **M. brenesii**
         6. Pecíolos 12–35 mm largo _____ **M. occidentalis**
   4. Hojas glabras a glabradas en el envés o con la pubescencia restringida solo a las nervaduras _____ **(M. occidentalis)**
      7. Hojas largamente lineares _____ **M. linearifolia**
      7. Hojas no lineares, de variadas formas.
         8. Flores conspicuamente pediceladas, flores no dispuestas en glomérulos; frutos menos 1 cm diámetro, globosos _____ **M. idiopoda**
         8. Flores sésiles, subsésiles o inconspicuamente pediceladas, generalmente dispuestas en glomérulos; frutos más 1.5 cm diámetro, obovoides a piriformes.
            9. Ramos laterales de la inflorescencias inconspicuos, inflorescencias pareciendo racemosas o espiciformes _____ **M. grandiflora**
            9. Ramos laterales de la inflorescencias conspicuamente desarrollados, inflorescencias claramente paniculadas.
               10. Láminas foliares conspicuamente bulladas, revolutas marginalmente en toda su longitud _____ **M. frondosa**
               10. Láminas foliares no bulladas o solo muy levemente, los márgenes no revolutos o solo justo antes de la unión de la lámina con el pecíolo.
                  11. Láminas foliares usualmente revolutas hacia la base, justo antes de la unión del pecíolo y la lámina _____ **M. hartshornii**
                  11. Láminas foliares no revolutas basalmente.
                     12. Inflorescencias mayormente caulifloras, más raramente axilares, glabras, glabradas a muy esparcidamente puberulentas, no ferrugíneas _____ **M. glabrata**
                     12. Inflorescencias mayormente terminales o subterminales, puberulentas o diminutamente ferrugíneo-puberulentas en la antésis.
                        13. Hojas subsésiles, pecíolo menos de 9 mm largo (hasta 12 mm en hojas muy desarrolladas); lámina obovada a angostamente obovada, gradualmente atenuadas hacia el pecíolo, con la base obtusa o redondeada; tallos jovenes algo angulados.
                           14. Lámina (28–)34–68 3 7.5–18 cm; frutos 2.2–2.4 cm largo; pétalos 1–1.5 mm; inflorescencias 17–65 cm largo _____ **M. donnellsmithii**

14. Lámina (7–)10–33(–35) 3 (2–)4–8.5 cm; frutos 1.7–1.8(–2) cm largo; pétalos 2–2.5 mm; inflorescencias 17–26 cm largo _____ **M. clandestina**

13. Hojas pecioladas, pecíolo 1–3.5 cm largo; lámina elíptica, con la base cuneada; tallos jovenes teretes a subteretes.
    15. Inflorescencias con las flores laxamente distribuidas; 100–800(–1200) m _____ **M. occidentalis**
    15. Inflorescencias con las flores densamente aglomeradas; 1000–2300 m.
        16. Inflorescencias con el eje principal glabro a glabrado y los ejes axilares esparcidamente puberulentos, la pubescencia no ferrugínea; 1000–1100 m _____ **M. chiriquensis**
        16. Inflorescencias con el eje principal y los ejes axilares ferrugíneo-puberulento a densamente ferrugíneo-puberulentas; 1100–2300 m _____ **M. vernicosa**

1. Meliosma allenii Standley & L.O. Williams, Ceiba 3:213. 1953. *Meliosma maxima* Standley & L.O. Williams, Ceiba 1:242. 1951, non Standley & Steyermark, 1944. *Meliosma longipetiolata* Standley & L.O. Williams ex Brizicky, Trop. Woods 110:39. 1959. TIPO. Costa Rica. Puntarenas: Palmar Norte, *Allen 5648* (HOLOTIPO: F; ISOTIPOS: F, MO, US).

Distribución.—Costa Rica y Panamá, 0–600(–1000) m. Este nombre ha sido utilizado para algunos especímenes provenientes de Perú y depositados en el Jardín Botánico de Missouri (MO). Sin embargo, probablemente representen otra entidad, dado que la morfología de las hojas y los frutos es diferente. En adición, la mayoría de los especímenes son estériles.

Fenología.—Especímenes con flores han sido recolectados entre Marzo y Junio. Especímenes con frutos se reportan durante Abril a Diciembre.

Una de las especies más comunes en zonas bajas, donde puede llegar a ser bastante común a lo largo de cauces de agua. Solamente existe otra especie con hojas largamente pecioladas en Costa Rica y Panamá, *Meliosma depressiva* (descrita aquí), pero *M. allenii* se reconoce por sus hojas con láminas glabras a glabradas en el envés, flores usualmente anaranjadas a crema-anaranjadas y distribución altitudinal diferente.

2. Meliosma brenesii Standley, Publ. Field Mus. Nat. Hist., Bot Ser. 18:648. 1937. TIPO. COSTA RICA. ALAJUELA: La Palma de San Ramón, 1050 m, *Brenes 5556* (HOLOTIPO: F; ISOTIPOS: CR, NY).

Distribución.—Costa Rica y el Norte de Panamá, 500–1200(–1700) m.

Fenología.—especímenes con flores se han recolectado entre Junio y Agosto.

Dentro del grupo de especies con hojas pubescentes y pecíolos cortos presentes en Costa Rica y Panamá, *Meliosma brenesii* puede ser confundida con *M. subcordata*, con la cual comparte láminas foliares, áreas de distribución geográficas y preferencias ecológicas similares. Sin embargo, *M. brenesii* se puede

reconocer fácilmente por sus hojas con la lámina cuneadas a obtusas en la base, no cordadas en la base.

3. Meliosma chiriquensis J.F. Morales, sp. nov. (**Fig. 1**). TIPO. PANAMÁ. CHIRIQUÍ: vicinity of Fortuna Dam, 11 Feb 1987 (fl), *McPherson 10480* (HOLOTIPO: INB; ISOTIPO: MO).

A *Meliosma vernicosa* cui affinis, foliis subopuesta vel verticillatis, inflorescentiis puberulis differt. Arbor. Folia simplicia, 7.7–11.6 cm × 4–6.2 cm, eliptica, glabrata, subopuesta vel verticillata. Inflorescentia ramiflora, pyramidale paniculata, terminales vel subterminale, floribus sessilis, sepala ciliata, glabrata. Fructus ignotus.

Arbol 18 m; ramas glabras o glabradas. Hojas subopuestas a subverticiladas; pecíolo 2–2.7 cm largo, glabro a glabrado; lámina 7.7–11.6 × 4–6.2 cm, elípticas, redondeadas a raramente emarginadas apicalmente, cuneadas en la base, subcoriáceas, enteras, glabras o glabradas. Inflorescenicas ramifloras, terminales a subterminales, más raramente axilares, piramidal paniculada, esparcidamente puberulentas, especialmente los ejes secundarios, 7–11 cm largo; flores sésiles a subsésiles, sépalos 5, ovados, anchamente agudos a obtusos apicalmente, ciliados marginalmente, pero el resto glabros a glabrados; pétalos blancos, 1.8–2 mm largo, anchamente ovados, glabros; ovario menos de 1 mm largo. Frutos desconocidos.

Distribución.—endémica por el momento al norte de Panamá, pero podría estar presente en el sur de Costa Rica, 1000–1100 m. Conocida únicamente por la colección tipo.

Fenología.—Floración en Enero y Febrero.

Esta especie se encuentra algo relacionada con *Meliosma vernicosa*. Ambas especies comparten inflorescencias con estructuras morfológicas y preferencias ecológicas similares, pero *M. chiriquensis* se reconoce por sus hojas mayormente subopuestas o subverticiladas e inflorescencias mucho más cortas, esparcidamente puberulentas y con la pubescencia no ferrugínea.

4. Meliosma clandestina J.F. Morales, sp. nov. (**Fig. 2**). TIPO. COSTA RICA. SAN JOSÉ: Cantón de Dota, Fila Dota, camino entre San Joaquín y Naranjito, 600 m, Mar 2001 (fl,fr), *Morales 7626* (HOLOTIPO: INB; ISOTIPOS: COL, CR, F,G, K, MEXU, MO, NY).

A *Meliosma donnellsmithii* cui affinis, folia minor, fructus major differt. Arbor. Folia simplicia, (7–)10–33(–35) cm × (2–)4–8.5 cm obovata, glabrata. Inflorescentia ramiflora, paniculata, terminales vel subterminales, floribus sessilis, sepala ciliata, glabrata. Fructus 1.7–1.8(–2) cm × 1.4–1.7 cm, obovoideus.

Arbol 5–11 m; ramas glabradas o muy inconspicua y esparcidamente puberulentas. Hojas alternas a subopuestas en el final de las ramitas; pecíolo 0.2–0.5 cm largo, glabro a glabrado; lámina (7–)10–33(–35) × (2–)4–8.5 cm, obovadas a angostamente obovadas, agudas a acuminadas (raramente obtusas) apicalmente, largamente atenuadas hacia la base, pero redondeadas u obtusas en la base, cartáceas a subcoriáceas, enteras o subenteras y con muy pocos y casi inconspicuos dientes, glabras o glabradas y con solo el nervio central puberulento. Inflorescencias ramifloras, terminales a subterminales, paniculadas,



FIG. 1. *Meliosma chiriquensis* J.F. Morales (*McPherson 10480*, INB). **A.** Hábito.

puberulentas, no ferrugíneas, (8–)17–26 cm largo; flores sésiles a subsésiles y con pedicelos de hasta 1 mm; sépalos 5, ovados, anchamente agudos a obtusos apicalmente, ciliados marginalmente, pero el resto glabro; pétalos amarillos a crema, 2–2.5 mm largo, anchamente ovados, glabros; ovario ca. 1 mm largo. Frutos 1.7–1.8(–2) × 1.4–1.7 cm, obovoide.

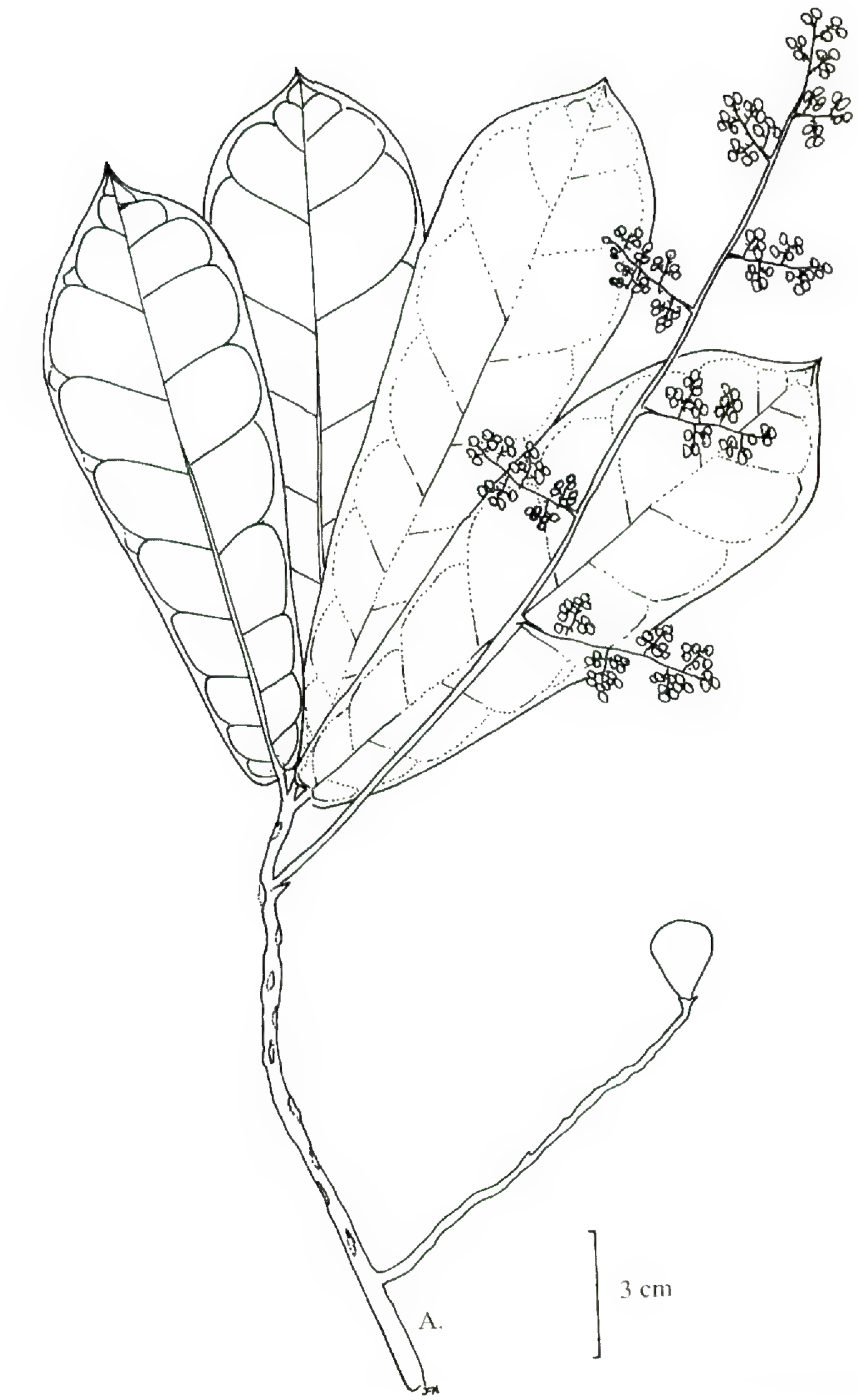


Fig. 2. *Meliosma clandestina* J.F. Morales (*Morales 7626*, INB). **A.** Hábito, inflorescencia y fruto.

Distribución.—Endémica a Costa Rica, en las faldas costeñas del Pacífico Central y Sur y la Península de Osa, 100–900 m.

Fenología.—Especímenes con flores y frutos han sido recolectados entre Julio, Setiembre y Febrero.

Algunos especímenes de esta especie fueron tratados bajo el concepto de

Meliosma donnellsmithii en el tratamiento de Sabiaceae para la Flora de Panamá, pero tal y como Gentry lo mencionó (1980), existían carácteres que sugerían que el material de Costa Rica de la Península de Osa en realidad correspondía a otra especie diferente. Colecciones adicionales acumuladas desde esa época muestran que en efecto se trataba de una especie sin describir. Los caracteres más importantes para separar *M. clandestina* de *M. donnellsmithii*, incluyen frutos y hojas conspicuamente más pequeños y flores más grandes.

PARATIPOS. **COSTA RICA. Puntarenas:** forested slopes above Golfito, 27–28 Ene 1967, *Burger & Mata 4696* (CR, F, MO); Parque Nacional Corcovado, Llorona, 13 Jul 1977, *Liesner 3227* (CR, MO). **San José:** Cantón de Puriscal, Cuenca del Tulín, Fila Cangreja, 15 Set 1998, *Acosta 22* (INB); Reserva Forestal La Cangreja, Mastatal de Puriscal, 22 Jul 1988, *Hammel et al. 17116* (INB, MO); Pérez Zeledón, cuenca del Barú, Fila Tinamastes, 9 Set 1996, *Hammel et al. 20431* (INB, MO); Santa Rosa de Puriscal, 4 Feb 1973, *Poveda 480* (CR).

5. Meliosma cordata A. Gentry, Ann. Missouri Bot. Gard. 67:954. 1980 [1981]. TIPO. PANAMA. VERAGUAS: lower slopes of Cerro Tute, ca. 10. km NW of Santa Fe, 750–1000 m, 19 May 1975 (fr), *Mori 6297* (HOLOTIPO: MO [2 partes]).

Distribución.—Sur de Costa Rica y norte de Panamá, 750–1850 m.

Fenología.—Especímenes con flores han sido recolectados entre Marzo y Abril. Frutos se reportan de Marzo a Mayo.

Esta especie era anteriormente conocida únicamente por la colección tipo, pero ahora es reportada de Costa Rica. Se encuentra bastante relacionada con *Meliosma depressiva* (descrita aquí), pero se reconoce por sus hojas con la lámina basalmente cordada y frutos más pequeños; en adición, sus sépalos y pétalos son más grandes.

Especímenes representativos examinados. **COSTA RICA. Puntarenas:** foothills of the Cordillera de Talamanca, around Tres Colinas, 1800–1850 m, 20 Mar 1984, *Davidse et al. 25672* (INB, MO); Cantón de Buenos Aires, Puesto Tres Colinas, Río Guineo, 17 Set 1996, *Gamboa & Picado 649* (INB, MO).

6. Meliosma depressiva J.F. Morales, sp. nov. (**Fig. 3**). TIPO. COSTA RICA. SAN JOSÉ: Cantón de Aserrí, Fila Bustamante, Hacienda Tiquires, Fila Aguabuena, bosque a camino al Alto La Araña, 1900–2000 m, 11 May 1996 (fl), *Morales & Ulate 5379* (HOLOTIPO: INB; ISOTIPOS: CR, F, MO).

Arbor parva. Folia simplicia, 9–30 cm × 5–12 cm, eliptica, obovata-elíptica vel lanceolata, puberula. Inflorescentia ramiflora vel cauliflora, paniculata, floribus pedicellatis, sepala tomentosa. Fructus 2.2–2.7 cm × 1.6–1.8 cm, obovoideus.

Arboles o arbustos 3–7 m; ramas densamente ferrugíneo-tomentulosos o densamente puberulentos cuando jovenes, glabrados y muy esparcida e inconspicuamente puberulentos con la edad. Hojas alternas a subopuestas en el final de las ramitas; pecíolo 4.5–12 cm largo, raramente menos de 4 cm en hojas inmaduras y jovenes, moderada a esparcidamente puberulento, muy rara vez glabrado; lámina 9–30 × 5–12 cm, elípticas, obovado-elípticas a anchamente lanceoladas, agudas a acuminadas apicalmente, obtusas en la base, subcoriáceas, enteras o con muy pocos e inconspicuos dientes, esparcidamente puberulentas en el envés, la lámina glabrada cuando vieja, y con la pubescencia restringida al nervio central puberulento. Inflorescencias ramifloras a cauliflloras, axilares,

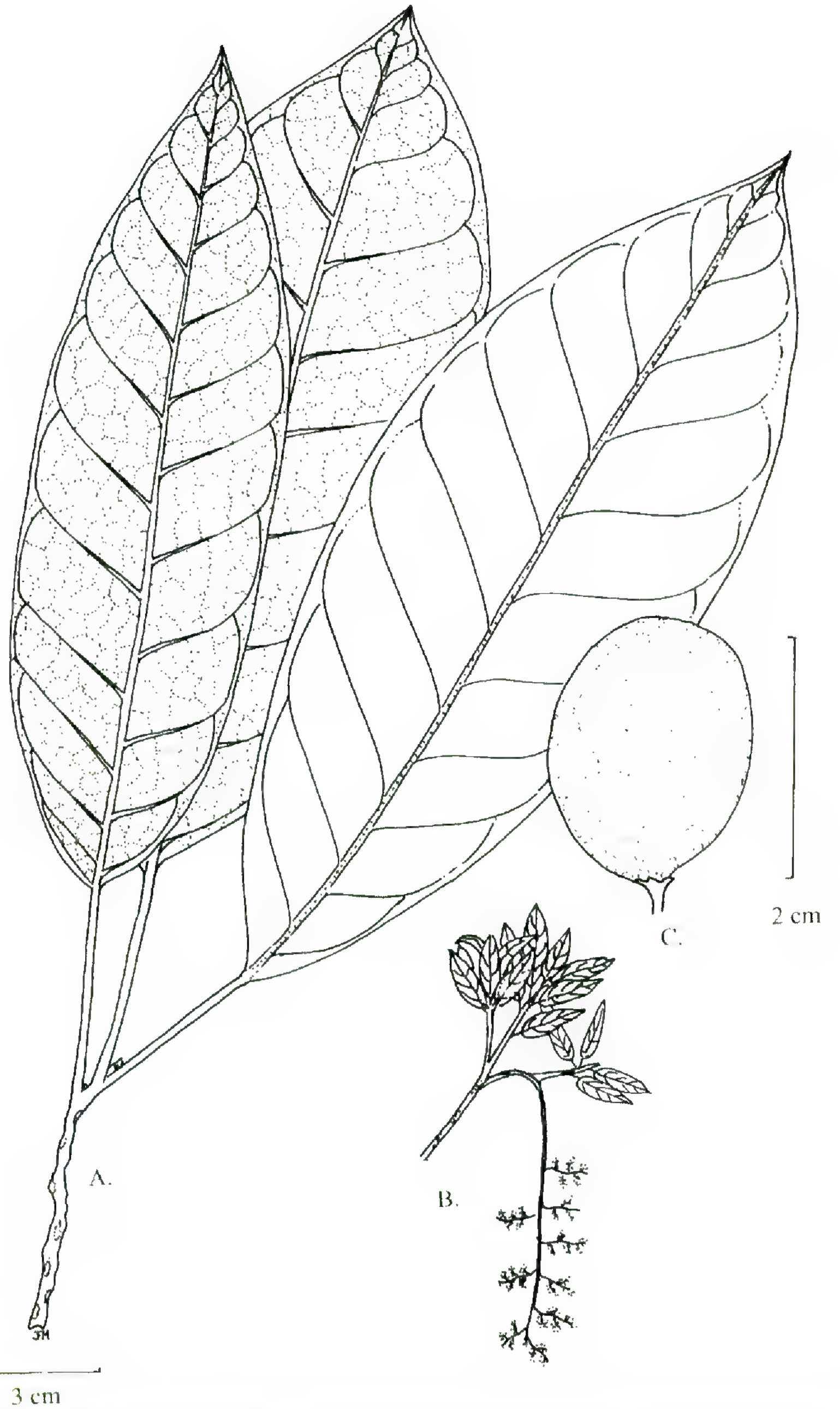


FIG. 3. *Meliosma depressiva* J.F. Morales (*Morales & Ulate 5379*, INB). **A.** Hábito. **B.** Inflorescencia. **C.** Frutos.

paniculadas, densamente puberulentas a tomentuloso-puberulentas, 20–75 cm largo; flores subsésiles y con pedicelos 0.5–1.5 mm; sépalos 5, ovados, anchamente agudos apicalmente, densamente puberulentos a tomentulos-puberulentos; pétalos rojo.vino a rojo-marrón, ca. 2 mm largo, anchamente ovados, glabros; ovario ca. 1 mm largo. Frutos 2.2–2.7 × 1.6–1.8 cm, subesférico.

Distribución.—Endémica a Costa Rica, donde se encuentra en la Cordillera Volcánica Central, Cordillera de Talamanca, Zona Protectora Cerros de Turrubares y en la Fila Aguabuena, en las vertiente pacífica, 1300–1900 m. Probablemente también en Panamá, en las provincias de Chiriquí y Bocas del Toro.

Fenología.—flores y frutos observadas de Enero a Setiembre, pero mayormente entre Abril y Agosto.

Meliosma depressiva puede distinguirse por sus hojas largamente pecioladas, inflorescencias usualmente muy largas y generalmente pendulosas, las cuales pueden alcanzar más de 75 cm de largo, con las flores rojo vino a rojo oscuro y distribución altitudinal sobre los 1300 m. Varias de las colecciones de *M. depressiva* se encuentran erróneamente identificadas como *M. vernicosa*, ya que ambas especies comparten características morfológicas similares, pero esta última se distingue por sus hojas con pecíolos más cortos, y con la lámina foliar glabra a glabrada. En Costa Rica y Panamá, *M. depressiva* es también similar a *M. allenii* (vease discusión previa).

En Mesoamérica, *M. depressiva* puede ser confundida con *M. grandifolia*, distribuida de México a Nicaragua (Matagalpa), pero esta última especie tiene la pubescencia de sus hojas conspicuamente hirsuta y erecta, no adpresa como en *M. depressiva*. En adición esta nueva especie se encuentra algo relacionada con *M. pittieriana*, distribuida en Colombia, Venezuela, Ecuador y Perú, pero sus láminas foliares son más angostas y sus flores son rosadas.

PARATIPOS. **COSTA RICA. Cartago:** near Río Naranjo, E of Cachí, 11 Jul 1971, *Lent 2002* (F, MO). **Heredia:** between Trinidad and Coliblanco, 25 Jul1975, *Utley & Utley 2718* (CR, F, MO [2 láminas]). **Puntarenas:** Buenos Aires, Parque Internacional La Amistad, Altamira, 6 Mar 1999, *Alfaro & Alfaro 2174* (CR, INB, MO); Buenos Aires, estación Altamira, 6 Dic 1999, *Alfaro 2604* (CR, INB, MO); Parque Internacional a Amistad, Cordillera de Talamanca, Pittier, 8 Jun 1995, *Angulo 329* (INB); foothills of the Cordillera de Talamanca, around Tres Colinas, 20 Mar 1984, *Davidse et al. 25672* (INB, MO); foothills of the Cordillera de Talamanca, between Agua Caliente and Río Canasta, 8 Set 1984, *Davidse et al. 28306* (CR, MO); around Río Canasta, between Cerro Frantzius and Cerro Pittier, 6 Set 1984, *Davidse et al. 28409* (MO); Parque La Amistad, Pittier, sendero a Río Gemelo, 30 Ene 1995, *Fletes 29* (INB, MO); La Amistad, sendero a Cerro Pittier, 15 Jun 1995, *Gamboa 252* (INB, MO); Zona Protectora Las Tablas, near Las Alturaas biological station, Ene 1996, *Holl 1131* (CR); Parque Internacional La Amistad, estación Pittier, 1 Ago 1995, *Moraga 266* (INB); Parque Internacional La Amistad, estación Altamira, Río Colorado, 9 Abr 1996, *Villalobos 301* (CR, INB, MO). **San José:** Pérez Zeledón, Santa Elena, 13 Set 1997, *Alfaro & Segura 1382* (INB, MO); Pérez Zeledón, Chumasquera, 16 Feb 2000, *Alfaro & Castro 2836* (INB, MO); Zona Protectora Cerros de Turrubares, faldas Cerro Turrúbares, 31 Mar 1990, *Zúñiga et al. 166* (CR, MO).

7. Meliosma donnellsmithii Urban, Bot. Gaz. 37:214. 1904. TIPO. COSTA RICA. CARTAGO: Río Turrialba, 500 m, Mar 1896 (fl), *Donnell Smith 6852* (HOLOTIPO: US; ISOTIPO: NY).

Distribución.—Nicaragua y Costa Rica, 0-750 m.

Fenología.—Floración de Abril a Julio.

Esta especie se reconoce fácilmente por el tamaño y forma de sus hojas, usualmente subsésiles o muy cortamente pecioladas (menos 12 mm). Anteriormente este nombre fue utilizado para dos especies diferentes, una de ellas previamente no descrita (vease discusión en *M. clandestina*).

8. Meliosma frondosa Cuatrecasas & Idrobo, Caldasia 7:193. 1955. TIPO. COLOMBIA. Cundinamarca: Zipacón, cabeceras del Río Apulo, entre la Hacienda Sebastopol y Dos Caminos, 1900–2100 m, 24 Dic 1953 (fl), *Idrobo & Hernández 1532* (HOLOTIPO: COL; ISOTIPOS: F, NY, US).

Distribución.—Panamá, Colombia, Ecuador, Venezuela, Perú y Bolivia, 1600-3100 m.

Fenología.—Floración entre Diciembre y Enero.

Esta especie se reconoce fácilmente por sus hojas conspicuamente bulladas y algunas veces revolutas marginalmente. La única especie con hojas conspicuamente bulladas y revolutas marginalmente en Mesoamérica es *M. linearifolia*, pero la forma de las láminas es totalmente diferente.

9. Meliosma glabrata (Liebmann) Urban, Ber. Deutsch. Bot. Ges. 13:212. 1895. *Lorenzanea glabrata* Liebm., Vidensk. Meddel. Dansk Naturhist. Foren. Kjobenhavn 1850: 71. 1850. Tipo. Costa Rica. Cartago: Turrialba, 1845 (fl), *Oersted s.n.* (HOLOTIPO: C; photograph Field negative 13373, INB).

Lorenzanea ira Liebm., Vidensk. Meddel. Dansk Naturhist. Foren. Kjobenhavn 1850:71. 1850. *Meliosma ira* (Liebm.) L.O. Williams, Fieldiana, Bot. 31:261-262. 1967. TIPO. COSTA RICA. ALAJUELA: Naranjo, May 1845 (fl), *Oersted s.n.* (HOLOTIPO: C, no examinado).

Meliosma tonduzii Donnell Smith, Bot. Gaz. 55:432. 1913. TIPO. COSTA RICA. CARTAGO: Tucurrique, 635-700 m, *Tonduz 13368* (HOLOTIPO: US; ISOTIPO: US).

Meliosma panamensis Standley, Trop. Woods. 10:49. 1927. TIPO. PANAMA. BOCAS DEL TORO: Almirante region, Changuinola valley, 1927 (fr), *Copper & Slater 29* (HOLOTIPO: US; ISOTIPOS: F, MO, NY).

Distribución.—México, Nicaragua, Costa Rica a Colombia, Ecuador y Perú, 500-1300 m.

Fenología.—floración Febrero a Junio.

Esta especie se reconoce fácilmente por tener inflorescencias mayormente cauliflоras. Aunque existen especímenes que pueden tener inflorescencias axilares, sus inflorescencias glabras o casi glabras las separan al instante de especies similares. Adicionalmente, puede confundirse con *M. occidentalis*, pero esta especie se reconoce por las láminas foliares usualmente pubescentes por el envés y las inflorescencias con flores muy laxamente distribuidas (vrs densamente aglomeradas en *M. glabrata*).

10. Meliosma grandiflora Morton ex A.H. Gentry, Ann. Missouri Bot. Gard. 67:957, fig. 1 C–D. 1980 [1981]. TIPO. COSTA RICA: vicinity of El General, 730 m, *Skutch 4049* (HOLOTIPO: MO; ISOTIPOS: CR, NY)

Distribución.—Costa Rica y Panamá, 0–1800 m.

Fenología.—flores observadas de Enero a Junio.

En Mesoamérica es la especie que tiene los pétalos más grandes. Se puede confundir con *Meliosma glabrata*, pero reconoce fácilmente por sus inflorescencias racemosas o espiciformes,con los ramos laterales conspicuos y por sus pétalos mucho más grandes.

11. Meliosma hartshornii A.H. Gentry, Ann. Missouri Bot. Gard. 73:820. 1986 [1987]. TIPO. COSTA RICA. HEREDIA: road to Volcán Barba, 2 km N of Sacramento, 2750 m, 29 Dic 1974 (fl), *Hartshorn 1608* (HOLOTIPO: MO; ISOTIPO: CR).

Distribución.—Costa Rica y Panamá, 2300–3000 m.

Fenología.—floración de Octubre a Marzo y Junio.

Restringida a las regiones más altas de la Cordilleras, esta especie se reconoce por sus hojas glabras a glabradas, con la lámina conspicuamente revoluta basalmente e inflorescencias claramente paniculadas, con las flores sésiles a subsésiles.

12. Meliosma idiopoda Blake, J. Wash. Acad. Sci. 14:289. 1924. TIPO. COSTA RICA. CARTAGO: Tucurrique, 635–700 m, *Tonduz 13372* (HOLOTIPO: US).

Meliosma dives Standley & Steyermark, Publ. Field Mus. Nat. Hist., Bot. Ser. 23:60-61. 1944. TIPO. GUATEMALA. SUCHITEPÉQUEZ: eastern slopes of Volcán de Santa Clara, above Chiracao, May 1942 (fl), *Steyermark 46773* (HOLOTIPO: F).

Distribución.—México a Panamá, (500–) 100–2000 m.

Fenología.—Especímenes con flores han sido recolectados de Noviembre a Abril.

Meliosma idiopoda es fácilmente reconocible por sus hojas cortamente pecioladas, esencialmente glabras, inflorescencias con flores conspicuamente pediceladas y frutos muy pequeños, menores a 1 cm de diámetro. Llega a ser localmente abundante en las regiones donde crece y es sumamente atractiva durante la floración, por las numerosas inflorescencias que produce y la coloración blanca de sus flores.

13. Meliosma linearifolia A. Gentry, Ann. Missouri Bot. Gard. 67:960, fig. 1 A–B. 1980 [1981]. TIPO. PANAMÁ. PANAMÁ: Localidad exacta preservada, 12 Mar 1969 (fl), *Correa & Dressler 1148* (HOLOTIPO: MO; ISOTIPO: NY).

Distribución.—Endémica a Panamá.

Fenología.—El único especímen conocido hasta el momento, fue recolectado con flores en Marzo.

Una de las especies más distintivas especies en el género que se reconoce al instante por sus hojas lineares y muy largas. Despúes de la colección tipo, esta especie ha sido raramente colectada y ha sido incluida en la lista roja de especies amenazadas de la Unión Internacional para la Conservación de la Naturaleza (Hilton-Taylor, 2000). Por lo tanto, su localidad específica se omite.

14. Meliosma occidentalis Cuatrecasas, Lloydia 11:217. 1948. TIPO. COLOMBIA. VALLE: Río Anchicayá, 230-260 m, sin fecha (fl), *Cuatrecasas 15279* (HOLOTIPO: F; ISOTIPOS: COL, US).

Distribución.—México (?), Costa Rica, Panamá, Colombia y Ecuador, 100–800 (–1200) m.

Fenología.—floración en Setiembre y Octubre.

Este nombre ha sido utilizado en forma común y errónea, para identificar

especímenes pertenecientes a *Meliosma vernicosa* y en algunos casos *M. glabrata*. Prefiero no utilizar los carácteres de venación pubescente empleados por Gentry (1980) y Durán (1997), ya que aunque es notable que esta especie tiene mayormente nervios y pecíolos diminutamente puberulentos, también he encontrado al menos 2 especímenes con hojas totalmente glabras. El carácter más distintivo para separarla de las especies relacionadas son las flores laxamente dispuestas de sus inflorescencias.

También puede ser confundida con *M. depressiva*, con quién comparte formas de hoja y pubescencia similares, sobretodo en especímenes con brotes muy jovenes de ramas, pero se reconoce por sus pecíolos más cortos, flores más grandes y distribución geográfica usualmente diferente.

Aunque he revisado bastante material de Costa Rica y Panamá, solamente he podido ubicar tres especímenes con flores que encajan con la descripción original; sin embargo, uno de ellos que difiere por sus hojas más pequeñas y totalmente glabras, este especímen de la Península de Osa es ubicado tentativamente bajo este nombre e incluso podría representar otra especie diferente de Suramérica. Mucho otro material presente en herbarios e identificado con este nombre está estéril y no se puede tener certeza sobre su identificación.

Especímenes representativos examinados. **COSTA RICA. Heredia:** Cerros Sardinal, N of Chilamate, 10 Jul 1982 (fl), *Hammel & Trainer 13119* (DUKE, INB). **Limón:** Braulio Carrillo National Park, path beyond Río Sucio, May 1984, *Gómez et al. 22799* (CR, INB, MO). **Puntarenas:** Reserva Forestal Golfo Dulce, Playa Campanario, Sierpe, 12 Oct 1991, *Harmon 273* (INB).

15. Meliosma schlimii (Turcz.) Triana, Ann. Sci. Nat., Bot., ser. 5, 16:363. 1872.

Oligostemom schlimii Turcz., Bull. Soc. Imp. Naturalistes Moscou 31: 447. 1858. TIPO. Colombia. Santander del Norte: localidad perdida, *Schlim 702* (HOLOTIPO: G-DC, fotografía negativo Field 23600, INB).

Distribución.—Costa Rica a Colombia y Ecuador, 0–750 m.

Fenología.—Especímenes con flores han sido recolectados en Junio y Julio.

Se reconoce por la dimensión de sus hojas, densamente ferrugíneas a marrón puberulentas en el envés, subsésiles y atenuadas basalmente. En Mesoamérica, no esta relacionada cercanamente con ninguna otra especie.

16. Meliosma subcordata Standley, Publ. Field Mus. Nat. Hist., Bot. Ser. 18:649. 1937. TIPO. COSTA RICA. ALAJUELA: La Palma de San Ramón, 26 Oct 1922 (fl), *Brenes 3781* (HOLOTIPO: F; ISOTIPO: NY).

Distribución.—Endémica a Costa Rica, donde se encuentra restringida a la Cordillera de Tilarán, 1400–1600 m.

Fenología.—Floración Junio a Agosto.

No es una especie muy común en el campo, pero se reconoce al instante por sus hojas cortamente pecioladas, con la lámina densamente puberulenta en el envés y levemente cordadas basalmente. Aunque se podría considerar como

una variedad morfológica de *M. brenesii*, no se han encontrado variaciones morfológicas y traslapes entre los caracteres claves en las diferentes poblaciones examinadas en el campo que así lo sugieran.

18. Meliosma vernicosa (Liebm.) Griseb., Cat. Pl. Cub. 47.1866. *Lorenzanea vernicosa* Liebm., Vidensk. Meddel. Dansk Naturhist. Foren. Kjobenhavn 1850:72. 1850. TIPO. COSTA RICA. ALAJUELA: Naranjo, fecha perdida (fl), *Oersted s.n.* (HOLOTIPO: C; fotografía negativo Field 13379, INB).

Distribución.—Nicaragua, Costa Rica & Panamá, 1100-2300 m.

Fenología.—Flores observadas entre Junio y Julio.

Meliosma vernicosa ha sido comúnmente confundida con *M. depressiva*, pero se distingue por varios carácteres. En primer lugar, esta especie tiene hojas con pecíolos menos de 3.5 cm largo, en contraposición de *M. depressiva*, que tiene pecíolos usualmente más de 4.5 cm largo. La pubescencia de las hojas es también diferente siendo las hojas de *M. vernicosa* glabras a glabradas. Usualmente tiene inflorescencias más compactas, con flores cremas a blancas. Es importante aclarar para futuros monografiadores, que aunque la localidad del especimen tipo exacta es desconocida, este fue probablemente recolectada por Oersted en las faldas del Volcán Barva, en la Cordillera Volcánica Central, donde realizó varias colecciones. En esta zona, *M. vernicosa* es localmente abundante.

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BOOK NOTICES

MARK BLUMENTHAL. 2003. **The ABC Clinical Guide to Herbs.** (ISBN 1-58890-157-2 hdk.). Thieme New York, 333 Seventh Avenue, New York, NY 10001, U.S.A. (Orders: customerservice@theime.com, 800-782-3488, 212-760-0888). $49.95, 480 pp, 58 b/w photos, 29 b/w line drawings, 8 1/2" × 11 1/2".

This book must be the ultimate resource for information about each of the twenty-nine most frequently used herbs as judged by retail sales. It offers a detached review of the data of specific products which have been the subject of clinical studies.

There are two pages of clinical overviews, a patient information sheet, and a comprehensive monograph on each herb as well as two photographs and a line drawing. The primary and potential uses, pharmacological actions, dosage and administration, adverse effects and the regulatory status in various countries around the world are spelled out plainly for each herb. In addition, abundant references are included.

This should be a valuable book for the lay person as well as the clinician at a time when alternative medicines are being widely discussed.—*Ruth Ginsburg, Botanical Research Institute of Texas, Fort Worth, TX, U.S.A.*

GORDON R. HANKS (Editor). 2002. **Narcissus and Daffodil: The Genus *Narcissus*.** (ISBN 0-415-27344-7, hdk.). Taylor & Francis, 11 New Fetter Lane, London EC4P 4EE, UK and 29 West 35th Street, New York, NY 10001, U.S.A. (Orders: info@tandf.co.uk, www.tandf.co.uk, 44 (0) 207 583 9855, fax 44 (0) 207-842-2298, standing orders call 44 (0)1264 343071). £70 (±$120.00), 452 pp, 16 color photos, 13 b/w photos, 98 b/w drawings, 31 tables, 7" × 9 3/4".

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A NEW SPECIES OF *PACKERA* (ASTERACEAE: SENECIONEAE) FROM THE EDWARDS PLATEAU OF TEXAS

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ABSTRACT

Packera texensis, sp. nov., is described and illustrated. It is endemic to the granitic sands of the Central Mineral Region within the Edwards Plateau of central Texas where it is known from four counties.

RESUMEN

Se describe y se ilustra ***Packera texensis***, sp. nov. Es endémica de las arenas graníticas de la "Central Mineral Region" en la Meseta Edwards del centro de Texas, de donde se conoce en cuatro condados.

INTRODUCTION

Packera is a genus of 63 species that occur almost exclusively in North America and that have been treated historically as the "Aureoid" complex of the genus *Senecio*. Löve and Löve (1976) pointed out that this anomalous group of species has a chromosome base number of x = 22 or x = 23, unlike other members of *Senecio* which are characterized by having a number of x = 10. They proposed that Barkley's "Aureoid Senecios" be placed in a new genus, *Packera*, based primarily on gross morphology and chromosome number. The group has notably imprecise species boundaries and a complex taxonomic history (Bain 1988; Barkley 1962, 1963, 1968a, 1968b, 1978, 1980, 1988; Freeman & Barkley 1995; Kowal 1975; Packer 1972). During field work in central Texas, a species of *Packera* has been discovered that is distinct from others currently known.

DESCRIPTION

Packera texensis R.J. O'Kennon & D.K. Trock, sp. nov. (**Fig. 1**). TYPE: U.S.A. TEXAS. GILLESPIE CO.: Keese Road, 0.7 mi (11 km) N of Keese Sagebeil Road, ca. 18 mi (29 km) N of Fredericksburg, in soils derived from weathered granite and among granite boulders, 1720 ft (524 m), 5 Mar 2000, *R.J. O'Kennon & D.K. Trock 11059* (HOLOTYPE: BRIT; ISOTYPES: MEX, MSC, NY, TAES).

Propter laminas 1.5–4 cm latas lobis terminalibus grandibus, denique petiolos distinguibiles a *P. plattensis* arcte similans, sed am ca laminarum lateralibus irregularibus (non dentatis vel laceratis), caudice usque ad 5 mm (non 1–1.2) cm diametre, flosculis radii 13 (non 8), nec non habitu pereni (non bieni) prae clare distat.

Robust herbaceous perennial, arising from an erect woody taproot-like caudex 6–12 mm thick, glabrous to sparingly floccose about nodes and among heads of

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FIG. 1. Habit and floral details of *Packera texensis* (from holotype, BRIT).

capitulescence. Stems 2–4(–5) dm, single or 2–5, rarely in clusters of up to 20. Basal leaves petiolate, blades elliptic-ovate, broadly oblanceolate or lyrate, bases tapering, margins irregularly and deeply parted to irregularly lobed with 3–9 lobes on each side and again incised at apex, 4–7 cm long and 1.5–2.5 cm wide, usually about 2 times longer than wide, the petiole subequal to the blade; cauline leaves gradually or sometimes abruptly reduced distally, similar in aspect to the basal leaves. Capitulescence an open or congested corymbiform cyme of 4–20(–30) heads. Capitula campanulate; phyllaries 13 or 21, 5–7 mm long. Ray florets conspicuous, golden-yellow, ca. 13 in number, ligule 7–9(–10) mm long. Cypselae, 2.5–3.0 mm long, 0.5 mm wide, with thick appressed simple trichomes along the angles, pappi 5–7 mm long.

Habitat and Phenology.—Gillespie County lies on the northern boundary of the Balcones Canyonlands Association, an area of limestone plateaus deeply dissected by creeks and rivers on the Edwards Plateau. The county is on the southern boundary of the Llano Uplift or Central Mineral Region, where the soil is primarily made up of granite, sandstone, gneiss, schist, and granitic-derived sands. The Edwards Plateau is botanically well known and has long been recognized as a region of endemism (Correll & Johnston 1979).

Recent collections of *Packera texensis* were made in an area of dry granitic gruss near the boundary of Gillespie and Llano counties. The plants are site specific and relatively uncommon, and the species is currently known from only a few localities. *Packera texensis* arises quickly from evergreen winter rosettes during the January rains and blooms as early as the first week in February. Plants begin to senesce by the end of March during a rapid drying out of the substrate prior to the spring rainy season that beings in late April.

Additional collections examined: U.S.A. **TEXAS. Callahan Co.:** I-20 (old Rt. 80) frontage road N side, 1 km E of County Road CR 115, 15 Apr 2002, *R.J. O'Kennon 16020* (BRIT); 3 mi S of Eula along Hwy 603, 20 Mar 1963, *N.C. Henderson 63-45* (BRIT); 2 mi E of Clyde along Hwy 80, sandy roadside, 8 Apr 1962, *N.C. Henderson 62-67* (BRIT). **Gillespie Co.:** 3.5 mi N of Eckert on Hwy 16, 17 Mar 1964, *D.S. Correll 29037* (BRIT); Keese Road, 0.7 mi (11 km) N of Keese-Sagebeil Road, ca. 18 mi (29 km) N of Fredericksburg, decaying granitic gruss soils among granite boulders, 1720 ft (524 m), 20 Mar 1990, *R.J. O'Kennon 6577* (BRIT); 26 Feb 1991, *R.J. O'Kennon 8373* (BRIT); old Llano Road N of Fredericksburg, 21 Feb 1931, *E. Whitehouse 12050* (BRIT). **Llano Co.:** Enchanted Rock, granitic soil, partial shade, 18 Apr 1931, *E. Whitehouse 12054* (BRIT). **Mason Co.:** 1 mi S of Katemcy, granite outcrop, 5 Apr 1984, *S. Pence 82* (BRIT).

DISCUSSION

Packera texensis most closely resembles *P. tridenticulata* (Rydb.) W.A. Weber & A. Löve but it shares characteristics of *P. tampicana* (DC) C. Jeffrey as well as *P. plattensis* (Nutt.) W.A. Weber & Löve. Most specimens would key to *Senecio tridenticulata* (Rydb.) in Correll and Johnston's *Manual of the Vascular Plants of Texas* (1979). Some of the more pubescent specimens would key to *Senecio plattensis* (Nutt.).

Morphologically the new species differs from *P. tridenticulata* mainly in height, shape and size of leaves, leaf margins, ratio of petiole length to blade length, length of phyllaries, length and pubescence of achenes. It differs from *P. plattensis* in number of stems, type of perennating structures, amount of location of pubescence, number of ray florets, length of ligules, length and pubescence of achenes. It differs from *P. tampicana* in duration, number of stems, pubescence, overall leaf shape and degree of lobing of the margins, and number of ray florets. Characters useful in recognizing these species are listed in Table 1. Data in this table were obtained by the senior author from measurements made on dozens of herbarium specimens.

There are three other species of *Packera* in Texas, *P. glabella*, *P. obovata* and *P. tomentosa*. There is little likelihood that any of these species could be mistaken for *P. texensis*. *Packera glabella* has distinctly striated hollow stems, a short fibrous-rooted caudex, and leaves with margins pinnately lobed. *Packera ovobata* has abundant stolens, a rhizomatous caudex, and distinctly obovate leaves and *P. tomentosa* has persistent floccose pubescence covering all of the vegetative surfaces. In contrast to these three species *P. texensis* lacks the hollow striated stems, has a distinctly tap-rooted caudex, no stolons, leaves that are elliptic-ovate to oblanceolate with margins that are at most irregularly lobed and pubescence restricted to the leaf axils, lower petioles and inflorescence.

There are habitat and substrate preferences that may also be used to distinguish these four species. *Packera texensis* has been collected only on or near the Edwards Plateau in soils derived from igneous or metamorphosed igneous rocks such as granite, gneiss and schists. *Packera plattensis* has been collected from a wide variety of soil types, but is most abundant in the limestone and sandstone-derived soils of the Great Plains. *Packera tridenticulata* is a plant of the High Plains and foothills of the Rocky Mountains, while *P. tampicana* is always found in disturbed wet sandy or muddy sites. Distribution maps for the four species are provided in Figure 2.

Hybridization is apparently common in this genus, but there is no evidence that *P. texensis* hybridizes with any of its congeners. It is consistently distinct in morphology, habitat and substrate preference, and flowering phenologies. There is also good distributional data to support the recognition of the new species. Additional field and laboratory studies will undoubtedly contribute to our understanding of the relationship of *P. texensis* to other morphologically similar species.

KEY TO *PACKERA TEXENSIS* AND ITS IMMEDIATE ALLIES

1. Plants permanently floccose-tomentose at the base of the stem and in the axils of the leaves, lightly tomentose elsewhere _____ **P. plattensis**
1. Plants with light tomentum at the base of the stem and in leaf axils, glabrous elsewhere.

TABLE 1. Comparison of *Packera texensis* with selected congeners.

	P. texensis	**P. tridenticulata**	**P. plattensis**	**P. tampicana**
Duration and habit	Perennial, woody caudex, 4–12 mm thick, no stolons	Perennial, caudex, 2–4 mm thick, terminally branching taproot,	Biennial or perennial from erect or suberect caudex, may be stoloniferous	Annual from a slender taproot
Height	3–4(–5) dm	1–3(–4) dm	2–6(–7) dm	2–5(–6) dm
Number of stems	Single to several	Single to several	Usually single, rarely 2–3	Usually single, or rarely 2–6 clustered
Pubescence	Glabrous to lightly floccose near nodes and among capitula	Glabrous to lightly floccose near nodes	Floccose-tomentose at base of stem, in nodes, abaxial leaf surface and among capitula	Glabrous throughout
Leaf dimensions	Blades 4–8(–10) cm long, 1.5–2.5 cm wide	Blades 2–4(–5) cm long, 0.5–1.5 cm wide	Blades 2–7(–8) cm long, 1–3(–4) cm wide	Blades 4–12 cm long, 1–3(–4) cm wide
Petiole to blade ratio	Petioles subequal to blade	1–2 times longer than blade	1–1.5 times longer than blade	Petioles subequal to blade
Leaf blade shape	Elliptic-ovate to broadly oblanceolate	Lanceolate to narrowly oblanceoate	Elliptic-ovate to oblanceolate or rarely suborbicular	Oblanceolate to spatulate
Leaf margins	Irregularly incised or dissected to deeply parted or pinnatisect, occasionally lateral margins irregularly lobed	Entire, subentire or dentate near the apex, rarely sub-pinnatisect	Subentire to crenate, serrate-dentate or sublyrate	Deeply pinnate, 1–6 pairs of lateral lobes, large terminal lobes
Capitulescence	4–20(–30) capitula	4–12(–20) capitula	6–15(–20) capitula	4–15(–20) capitula
Phyllaries	13 or 21, 5–7 mm long, green, glabrous	13 or 21, 6–10 mm, green, sparsely tomentose proximally	13 or 21, 5–6 mm, green, densely tomentose proximally	13 or 21, 3–7 mm, green with reddish apices, glabrous
Ray florets	About 13	8–10, rarely 13	About 8	8 or 13
Ligule length	5–6(–7) mm	5–8(–9) mm	9–10(–11) mm	3–7 mm
Cypselae	1–1.5 mm long, thick appressed trichomes on the angles	1.5–2.5 mm long, glabrous or lightly hirtellous on the angles	1.5–2.5 mm, hirtellous on the angles or rarely glabrous	1–1.5 mm long, hirtellous on the angles

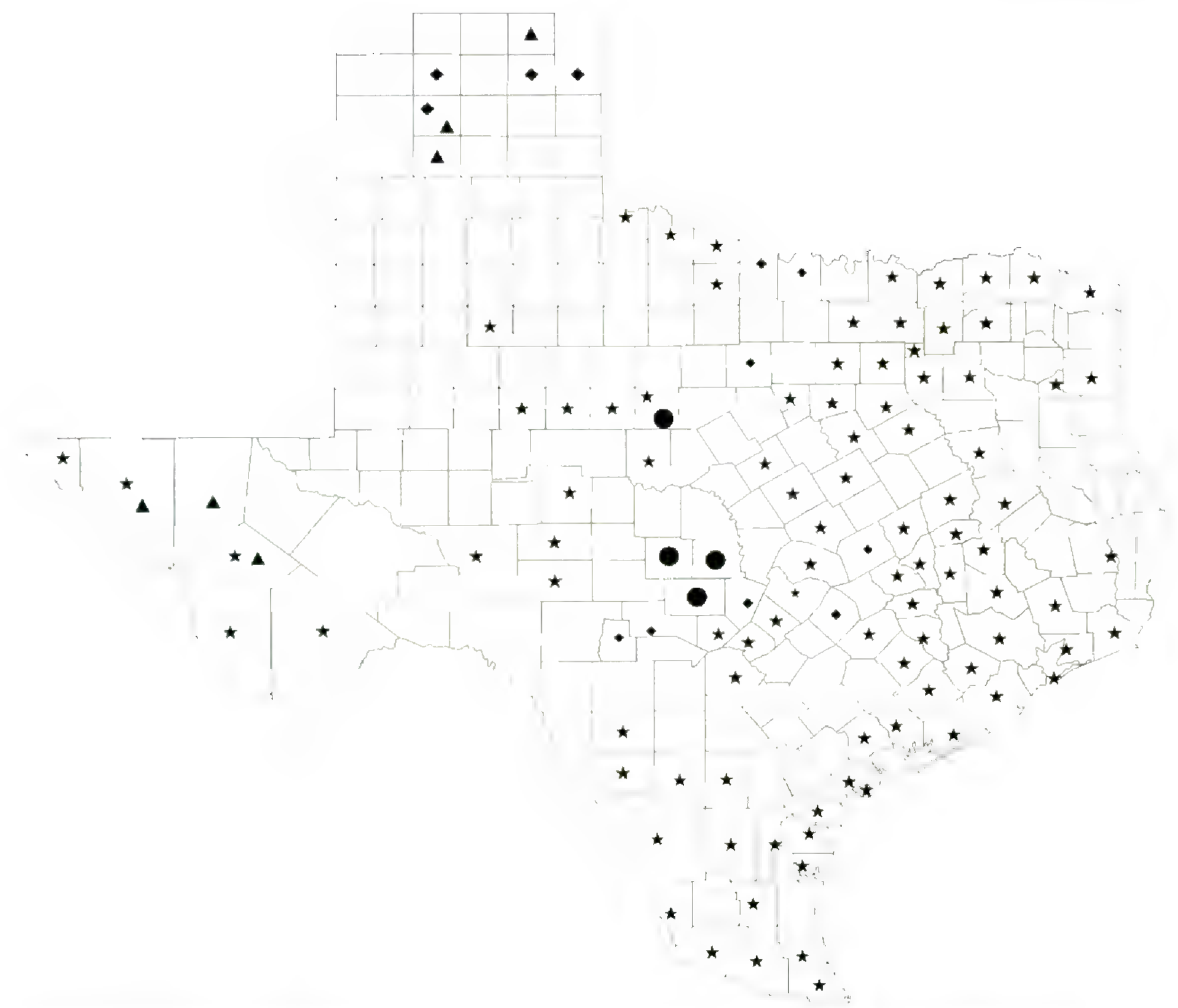


Fig. 2. Geographic distribution of four morphologically similar species of *Packera* in Texas. Circles = *P. texensis*; triangles = *P. tridenticulata*; diamonds = *P. plattensis*; stars = *P. tampicana*. Distributions are based on examination of over 300 herbarium specimens.

2. Basal leaves lanceolate or narrowly oblanceolate, margins entire, subentire to dentate near the apex or occasionally sub-pinnatisect _____ **P. tridenticulata**
2. Basal leaves elliptic-ovate, obovate or lyrate, margins lobed, parted or deeply incised.
   3. Annual, from a slender taproot _____ **P. tampicana**
   3. Perennial, from a stout, woody tap rooted caudex _____ **P. texensis**

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BOOK NOTICES

JOHN J.W. COPEN (Editor). 2002. **Eucalyptus: The Genus *Eucalyptus*.** (ISBN 0-415-27879-1, hdk.). Taylor & Francis, 11 New Fetter Lane, London EC4P 4EE, UK and 29 West 35th Street, New York, NY 10001, U.S.A. (Orders: info@tandf.co.uk, www.tandf.co.uk, 44 (0) 207 583 9855, fax 44 (0) 207-842-2298, standing orders call 44 (0)1264 343071). £55 (±$70.00), 496 pp., 6 b/w photos, 60 b/w drawings, 45 tables, 7" × 9 3/4".

This is volume 22 of the Medicinal and Aromatic Plants—Industrial Profiles, a series aimed at those engaged in research in botany, agriculture, pharmacognosy, phytochemistry, the food flavor, cosmetic and fragrance industries, alternative medicine and in other pharmaceutical and health sciences. *Eucalyptus* is a genus of over 800 species. Seventeen chapters provide in-depth coverage from general aspects to cultivation to commercial distillation. "Chapters on botany, environmental and ecological aspects, cultivation, genetic improvement, chemistry, bioactivity, oil distillation, formulations and legislation, and international trade and markets, re complemented by appendices which provide further practical help and advice." As the publisher suggests, the book will surely be a valuable source of information on *Eucalyptus* for researchers in academia and industry alike.

SARA OLDFIELD. 2003. **Rainforests.** (ISBN 0-262-15106-5 hbk.). The MIT Press, 5 Cambridge Center, Cambridge, MA 02142-1493, U.S.A. (Orders: http://mitpress.mit.order, mitpress-order@mit.edu, 1-800-405-1619). $29.95, 159 pp., 200 color photos, 1 map, 9 1/2" × 12 1/2".

This extremely informative and well-organized book deals with the major rainforest regions of the world - both tropical and temperate. The author describes the habitat, flora and fauna, and indigenous people of each unique location and explains the various threats to its survival. If the writing is a little pedestrian, the message is clear: the ecosystems of the rainforest are very fragile and in great danger.

The photographs, from the Bruce Coleman Collection are brilliant in conveying the beauty and wonderousess of each region and its denizens. They could stand on their own as a picture book. But with the text the book makes the most compelling case for the conservation of the rainforest and the preservation of the delicate balance between man and nature A list of membership and governmental organizations involved with rainforests is included in the book as well as a bibliography for more information. Royalties from Rainforest will go to the Global Trees Campaign of Flora and Fauna International (FFI) and the United Nations Environmental Program to save the world's most threatened trees.—*Ruth Ginsburg, Botanical Research Institute of Texas, Fort Worth, TX, U.S.A.*

STUDIES IN *GLANDULARIA* (VERBENACEAE): THE *GLANDULARIA QUADRANGULATA* COMPLEX

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ABSTRACT

This paper responds to Turner's inclusion of *Glandularia verecunda* and *G. racemosa* into *G. quadrangulata*. The latter has distinctive terminal appendages on the nutlets and the pericarp flares outward at the base; *G. verecunda*, is very similar vegetatively, has similar nutlets, but they lack the distinctive terminal appendage. Pollen/ovule ratios indicate that both taxa are facultative autogamous and both taxa have distinct ranges with limited areas of sympatry. No intermediates are known, and intermediate characteristics may not exist. They also differ in their flavonoid compliments supporting their recognition as distinct species. *Glandularia racemosa*, with larger corollas, a different nutlet type, and leaf structure, is a hexaploid (not tetraploid as in the other taxa) and represents a separate group within the genus and should not have been submerged into *G. quadrangulata*.

RESUMEN

Este artículo responde a la inclusión de Turner de *Glandularia verecunda* y *G. racemosa* en *G. quadrangulata*. Esta última tiene apéndices terminales distintivos en las núculas y el pericarpo se acampana hacia el exterior en la base; *G. verecunda*, es muy similar vegetativamente, tiene núculas similares, pero le falta el apéndice terminal distintivo. La relación polen/óvulos indica que ambos taxa son autógamos facultativos y ambos taxa tienen diferente distribución con áreas de simpatría limitada. No se conocen intermedios, y los caracteres intermedios puede que no existan. También se diferencian en su dotación de flavonoides que apoyan su reconocimiento como especies distintas. *Glandularia racemosa*, con corolas más grandes, un tipo diferente de núcula, y estructura de la hoja, es un hexaploide (no tetraploide como en los otros taxa) y representa un grupo separado en el género y no debería haber sido incluida en *G. quadrangulata*.

INTRODUCTION

Turner (1998) presented a new classification *Glandularia quadrangulata* (Heller) Umber submerging both *G. verecunda* Umber and *G. racemosa* (Eggert) Umber into *G. quadrangulata*. All three taxa are similar vegetatively. They are low-growing, branched, hairy, usually perennial herbs with broad, distally dissected leaves and have small, inconspicuous flowers with corolla limbs only 2.5–9 mm wide. Turner (1998) however, failed to take into consideration basic differences in nutlet structure, ploidy levels, and breeding systems of these taxa that support a different classification.

MATERIALS AND METHODS

The data presented here are based on empirical observations on specimens from the TEX-LL, SRSC herbaria. Direct counts of pollen grains were made from

unopened buds that were softened by boiling; the four anthers were opened directly on microscope slide.

RESULTS AND DISCUSSION

Nutlet structure.—Nutlets of *G. quadrangulata* are the most distinctive (Fig. 1 D). The nutlets are 3.3–4.2 mm long, the central bodies are slender, 0.55–0.65 mm wide, at the base and the outer pericarp wall greatly expands and flares outward to 1.2–1.6 mm in width. At the inner tip they have a large, thin, somewhat concave, ovate appendage 1.0–1.3 mm long. The inner or commissural surface of the nutlet is cream-white and covered with distinct papillate-aculeate excrescences. The commissural surface is nearly as wide as the nutlet in the central portion and extends to the top of the ovate appendage. The outer pericarp walls, as in most glandularias, are black, with a broad reticulate, raised pattern that extends from the tip about half way down the nutlets where it disorganizes into a series of vertical striae that extend to the nutlet base. The quartet of nutlets are so arranged that the flared bases expand over the receptacle and the distal appendages form a valvate dome over the developing nutlets through which the style extends from the tip of the united appendages. When the nutlets separate, they leave no distinctive receptacular rim.

The fruits of *Glandularia verecunda* are similar to those of *G. quadrangulata* except they lack the conspicuous terminal appendage (Fig. 1 H). They are (2.6–)2.8–3.2(–3.3) mm long, and the central body is also slender, 0.5–0.65 mm wide. The outer pericarp also abruptly flares out at the base to a width of 1.0–1.3 mm although this characteristic is not present in immature fruit. Again the inner whitish commissural face is nearly as wide as the central nutlet itself. The aculeate surface continues to the distal portion of the nutlet where its distal margin is rather truncated, sometimes retuse, marked by small horizontal beak that extends inward. The horizontal beak may be homologous to the much-expanded vertical beak in *G. quadrangulata*. In their broadly flared base and slender body, the broad commissural face of the nutlets are identical to those of *G. quadrangulata*.

Nutlets with similar slender bodies and greatly expanded bases occur in a small group of North American *Glandularia*, namely *G. polyantha* Umber, *G. delticola* (Small) Umber, and in two other taxa that also have greatly expanded air spaces in the adaxial portion of the nutlet: *G. tumidula* (Perry) Umber, and *G. brachyrhynchos* Nesom & Vorobik. Of note, the distinctive nutlet appendage is not unique to *G. quadrangulata* as it also occurs in species of southern South America (Uruguay, Brazil and Argentina) where *Glandularia tenera* (Spreng) Cabrera has an appendage similar to that of *G. quadrangulata* and *G. pulchella* (Sweet) Tronc. has a shorter, less-developed appendage. *Glandularia pulchella* is adventive in the United States from Florida into Texas and in northeastern

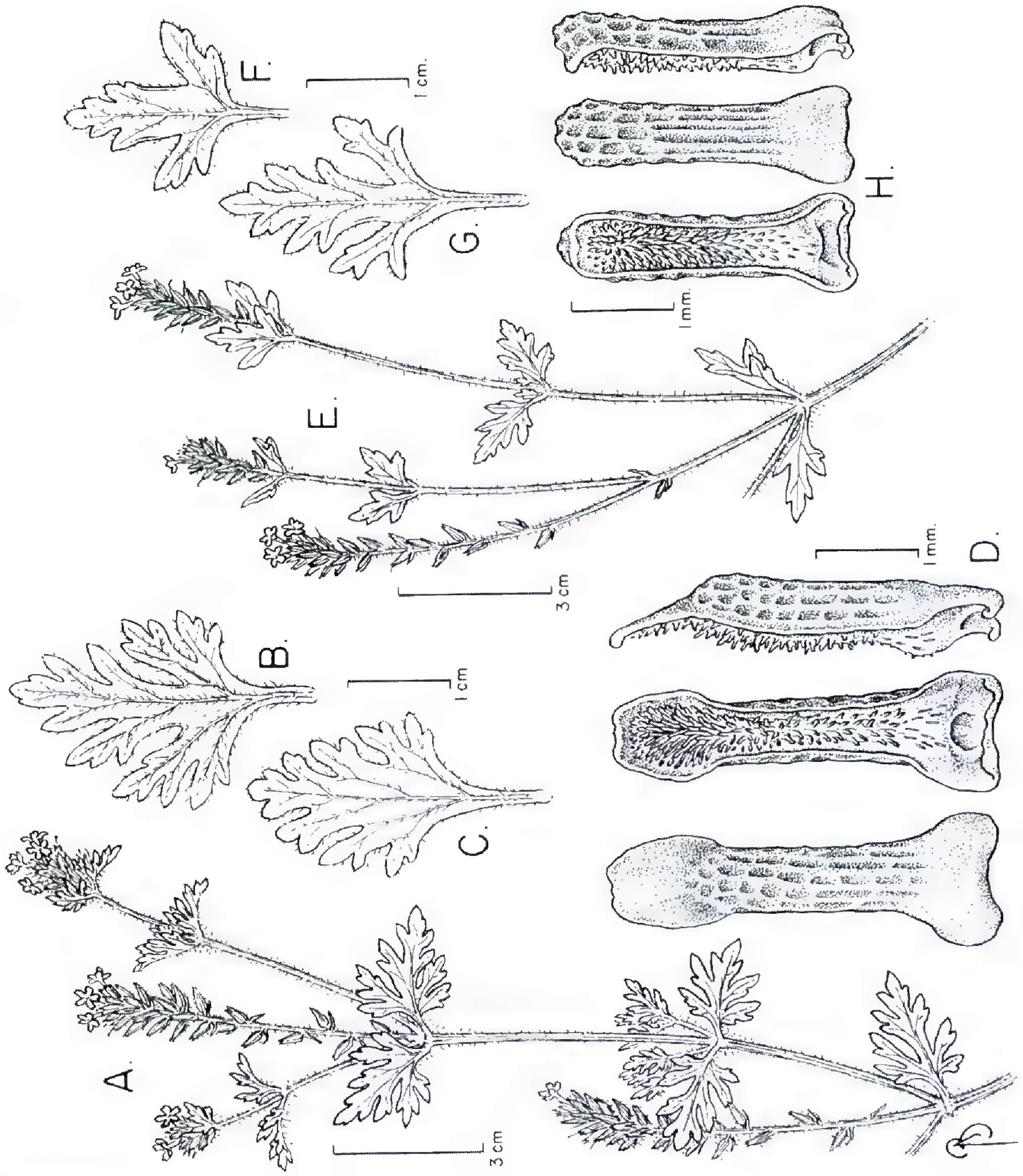


FIG. 1. *Glandularia quadrangulata* and *G. verecunda*. **A–D.** *G. quadrangulata*. **A.** Stem, showing leaves and inflorescences (*Lundell 9790*, LL); **B.** Leaf, adaxial view, (*Lundell 9790*, LL); **C.**–Leaf, adaxial view (*Turner 21-112*, TEX); **D.** Mature nutlets showing the distinctive ovate terminal appendage and broadly flaring basal pericarp as seen in abaxial view (left) showing outer reticulate pattern, (note broad expansion of nutlet base), in adaxial view (central) showing aculeate inner commissural surface nearly as wide as the nutlet, and in lateral view (right) showing adaxial location of the terminal appendage (all *Carr 15923*, TEX). **E–H.** *G. verecunda*. **E.** Stem, showing leaves and inflorescence (*Strohmeyer s.n.* TEX); **F.** Leaf, adaxial view (*Strohmeyer s.n.*, TEX); **G.** Leaf, adaxial view (*Henrickson 22775*, TEX); **H.** Mature nutlets showing lack of terminal appenadage and broad nutlet base in adaxial view (left) with aculeate commissural face nearly as wide as the mid-nutlet and continuing to near the nutlet tip, abaxial view (central) showing abaxial nutlet surface (note: reticulate pattern near the tip that breaks apart below into parallel lines below), and lateral view (right) showing the small beak-like projection at the tip (all *Bruno & Peña 38*, TEX). Magnifications as indicated.

Mexico; most plants show moderate appendages, in some plants they are poorly developed, shorter and more perpendicular to the nutlet axis. Nutlets of both species are illustrated in Burkart and Troncoso (1979).

The nutlets of *Glandularia racemosa*, however, are strongly different and are of a type widely occurring through most North American *Glandularia* (Fig. 2 I). The body of the nutlets are (2.0–)2.2–2.6(–2.8) mm long, slightly broader, the basal pericarps are only slightly expanded and the nutlets are rounded at the tip. Furthermore the whitish aculeate or otherwise marked commissural surfaces are much narrower than the width of the nutlets (often 0.25–0.3(–0.35) mm wide, with the nutlet being (0.55–)0.6–0.77 mm wide), and this whitish commissural surfaces extends to within 0.2–0.4 mm of the dome-like nutlet tips where they are distinctly rounded, not truncated or retuse. The blackened pericarp, however, has a similar raised reticulate pattern in the distal half that disorganizes into a series of vertical striae as in the other two species.

Cytology.—Umber (1977, 1979) presents chromosome counts for the three taxa. Both *Glandularia quadrangulata* and *G. verecunda* are tetraploid with $n = 10$. *Glandularia racemosa* in contrast, is hexaploid with $n = 15$. An older count by Dermen (1936) also shows hexaploidy for *G. racemosa* ($2n = 30$). This would not support submersion of *G. racemosa* into *G. quadrangulata*. Lewis and Oliver (1961) report $n = 10$ (tetraploid) for *G. racemosa* based on a *Lewis & Oliver 5416* collection from Coahuila, Mexico, however, Umber (1977) correctly notes this collection is *G. verecunda*, not *G. racemosa*.

Phytochemistry.—Umber (1977) notes that the west Texas populations of *Glandularia verecunda* and *G. racemosa* are similar in their flavanoids both producing 7-0-gentiobiosides and 7-0-sophorosides of apigenin, luteolin and chrysoeriol, while six south-Texas samples *G. quadrangulata* produced only 7-0-gentiobiosides (but not 7-0-sophorosides) of apigenin (its dominant flavonoid), with only trace amounts of 7-0-gentiobiosides of luteolin and chrysoeriol. The south Texas sample of *G. verecunda*, however, also produced only 7-0-gentiobiosides of apigenin, luteolin and chrysoeriol as in *G. quadrangulata*.

Biogeography.—Each of these three taxa have distinct ranges: *Glandularia quadrangulata* occurs from south-central Texas west to the Pecos River and to the border region of Mexico (Fig. 3). *Glandularia verecunda* occurs in trans-Pecos Texas, scattered in southern Texas, and continues south into Mexico in eastern Chihuahua, eastern Coahuila, south to near Monterrey in Nuevo León. *Glandularia racemosa* is restricted to trans-Pecos Texas (Fig. 3).

Breeding systems.—Flowers in both *Glandularia quadrangulata* and *G. verecunda* are very small having white to lavender corollas with very slender tubes 5.2–6.5 mm in length and limbs 2.5–5.2 mm in diameter. Within the tube, as in all glandularias, the style is initially situated between the two pair of introrse anthers among a series of downward-pointing stiff hairs (see Fig. 2 E–H).

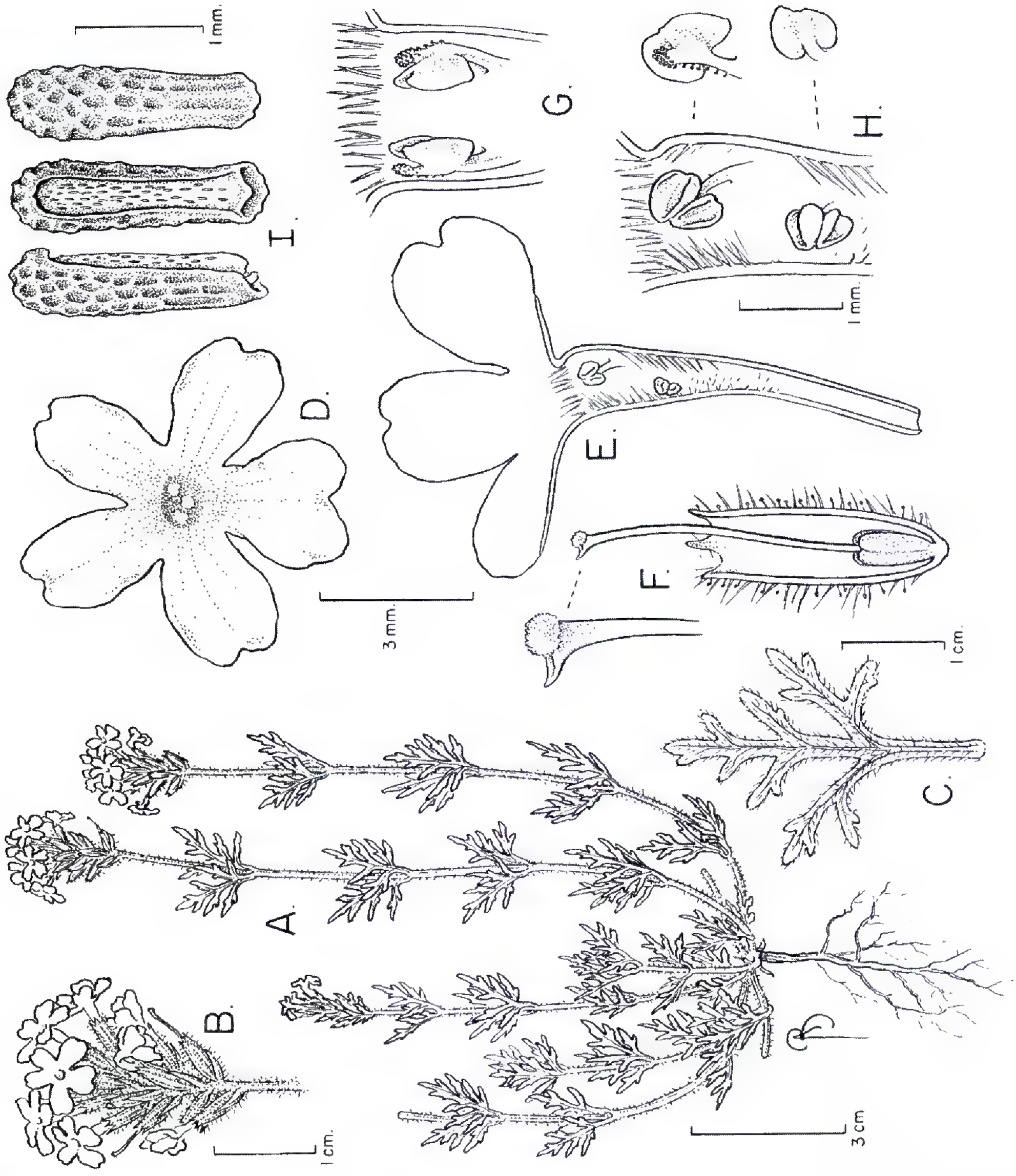


FIG. 2. *Glandularia racemosa*. **A.** Growth habit of young plant showing erect stems and terminal inflorescences (*Turner 21-212*, TEX); **B.** Inflorescence with corollas; (*Turner 21-212*, TEX); **C.** Leaf, adaxial view (*Turner 97-28*, TEX); **D.-H.** Floral structure (from re-expanded flowers of *Turner 21-74* TEX and others) **D.** Corolla, face view, showing larger, more emarginate abaxial corolla limb, and relatively smaller adaxial limbs; **E.** Medial section of corolla, showing separation of distal abaxial and more proximal adaxial stamens, the hairs at the corolla tube throat are moniliform, those of the tube are stiffer, more subulate; **F.** Medial section of calyx, showing ovary, style and stigma (offset). The stigma lies between the two pairs of stamens; **G.** Distal stamens, showing lateral glandular connective appendages; **H.** Distal and proximal stamens and associated hairs (note the connective appendage on the distal stamen–offset); **I.** Mature nutlets showing narrow nutlet base and relatively narrow commissural face, lateral view (left) showing reticulate abaxial surface, adaxial view (central) showing the narrow commissural face, and abaxial view (right) showing the reticulate surface pattern that is less organized below (*Warnock 46135*, TEX). Magnifications as indicated. Scale in D, holds for D, E, and F.

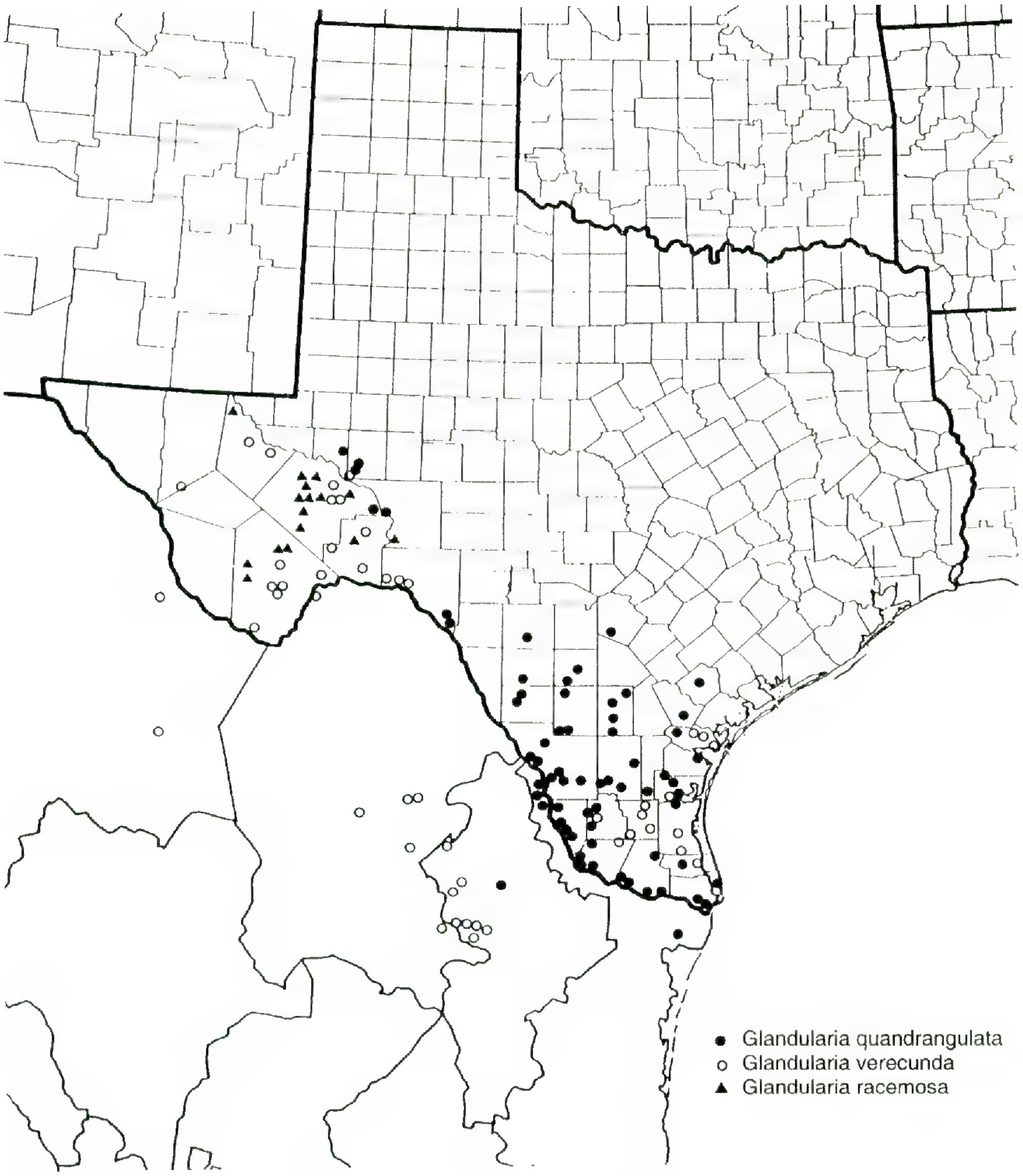


FIG. 3. Distributions of *G. quadrangulata* (solid circles), *G. verecunda* (hollow circles) and *G. racemosa* (solid triangles) in Texas and Mexico, from collections at TEX-LL and SRSC.

The basal two anthers are 0.3–0.6 mm long, with filaments to 0.3 mm long and contain fewer pollen grains than present in the slightly larger distal pair of anthers that are 0.4–0.8 mm long with filaments 0.3 mm long. As the flower matures, the style elongates pushing the stigma across the distal pair of anthers where pollen easily contacts the stigma. Unless some self-incompatability factors are at work, autogamy (inbreeding) is certainly possible. Regarding self incompatibility, I have observed that even isolated plants of *G. quadrangulata* set a full compliment of nutlets, and in most herbarium specimens, the plants have full

fruit set, leading me to believe that there is no self incompatibility involved in the reproduction of the taxon.

Cruden (1977) noted that pollen-ovule ratios can be used as an indicator of the breeding system in flowering plants. In his study, he indicated average pollen/ovule ratios of 4.7 (range 3–7) for cleistogamous taxa; 27.7 (range18–30) for obligate autogamous taxa; 168.5 (range 76–396) for facultative autogamous taxa; 796.6 (range 160–2,558) for facultative xenogamous (outbreeding) taxa; and 5859 (range 1,648–16,807) for obligate xenogamous taxa using his outcrossing index as a relative measure of inbreeding vs. outcrossing.

Glandularia species in North America differ strongly in corolla size, with larger flowers having larger anthers with more pollen. I measured pollen grain numbers per flower and correlated that with overall flower size (using maximum expanded diameter of the corolla limb as a gross measurement of corolla size) in several species of *Glandularia*. I found that plants with corolla limbs 9–13 mm in diameter had 2168–2677 pollen grains (5 counts) (average 2344 per flower, 586 pollen grains per ovule–four ovules per ovary). Flowers with corolla limbs 4–7 mm in diameter had 956–1410 pollen grains per flower (8 counts)(average 1275 per flower, 318 pollens per ovule) and those with corolla limbs 2–4 mm in diameter, had 580–1149 pollen grains (7 counts) (average 748 per flower, 187 pollen grains per ovule) indicating that most *Glandularia* were in the range of facultative autogamous. As noted above, the stigma is also produced in close association with the anthers in the distal corolla tube. For the species here in question, I found in four collections of *G. quadrangulata*, 580, 626, 615, 706 pollen per flower (mean of 157 per ovule-4 ovules per flower), (wetted corolla limb diameters 2.5, 2.5, 2.7, 2.5 mm respectively–see Table 1); for *G. verecunda* 1149, 870, 740, 692, pollen per flowers (mean of 218 per ovule), (corolla limb diameters of 2.5, 3.5, 5.2, 3.5 mm) and *G. racemosa* 2184, 2125, 1728, 1803 per flower (mean of 490 per ovule), (corolla limb diameters of 9.0, 8.5, 8.0, 7.8 mm). This would imply that the taxa, at least for *G. quadrangulata* and *G. verecunda*, are in the range of facultative autogamous taxa and *G. racemosa* is in the facultative xenogamous range.

Also, most plants, even isolated plants, exhibit full or nearly full fruit set. Umber, (pers. comm.) notes that in many *Glandularia* species, greenhouse grown plants produced full fruit set, in some species you had to push the flowering branches back and forth, similar to a wind action, to insure good fruit set. Even the few, widely isolated specimens of *G. quadrangulata* I observed in Kleberg Co., Texas, all had near complete fruit maturation. Though Umber 1977 notes that some populations of his *G. bipinnatifida* have low fruit set, indicating the possibility of local self incompatability. My conclusion is that *G. quandrangulata* and *G. verecunda* are capable of reproducing by autogamy, and that self incompatibility does not restrict fruit set, so that even if they occur in sympatric populations, gene exchange between them may be limited and inci-

TABLE 1. Pollen/ovule ratios of *Glandularia* species.

	Total pollen per fl.	p/o ratio	Corolla diameter
Glandularia quadrangulata			
Turner 97-01 Crockett Co., Tex.	580	145	2.5
W.R. Carr 11723 McMullen Co., Tex.	615	153	2.5
Williges 359 San Patricio Co., Tex.	626	156	2.7
V. Villarreal Kleberg Co., Tex.	706	176	2.5
	Average 157		
Glandularia verecunda			
Correll 20699 Brewster Co., Tex.	1149	287	2.5
Powell, Turner & Sikes Ojinaga, Chih., Mex.	870	217	3.5
Turner 97-86 Terrell Co., Tex.	780	195	5.2
Lundell & Lundell 10071 Brooks Co., Tex.	692	173	3.5
	Average 218		
Glandularia racemosa			
Turner 97-28 Pecos Co., Tex.	2184	546	9.0
Turner 97-212 Culberson Co., Tex.	2125	531	8.5
Turner 97 76 Brewster Co., Tex.	1728	432	8.0
Tharp& Havard 49359 Pecos Co., Tex.	1803	451	7.8
	Average 490		

dental. Certainly both taxa produce flowers with small corolla tubes that may be attractive to long-tongued flies (J. Neff, pers. comm.) but are certainly capable of self pollination.

Classification.—The relationship of *Glandularia racemosa* to the other two taxa, is very clear. While *G. racemosa* is somewhat vegetatively similar to both *G. quadrangulata* and *G. verecunda*, the leaves of *G. racemosa* are more deeply divided into linear segments (except in some large, perhaps shaded leaves of rapidly-growing specimens), its growth habit is different, initially briefly decumbent at the base with erect-ascending stems, but with age it becomes more spreading. Furthermore the fruits of *G. racemosa* are completely different as

discussed above and are of a type found in most North American *Glandularia*. Also both *G. quadrangulata* and *G. verecunda* are tetraploid ($n = 10$), while *G. racemosa* is hexaploid ($n = 15$). In addition the corollas of *G. racemosa* are larger [(5.5–)6–8(–9.0) mm in limb diameter] than those of *G. quadrangulata* [(2.0–)2.5–3.5(–4.5) mm diameter] and *G. verecunda* [3.2–4.5(–5.5) mm diameter]. Corolla limbs of *G. racemosa* are also usually white in color [rarely tinged with blue—which Umber (1977, 1979) considers indication of introgression with *G. bipinnatifida*], while those of *G. quadrangulata* and *G. verecunda* are more commonly lavender, only occasionally white in color. It is apparent that *G. racemosa* is not a taxonomic synonym of the *G. quadrangulata-verecunda* group and is a distinct, endemic species in trans-Pecos Texas. I find no support for Turner's inclusion of *G. racemosa* into his concept of *G. quadrangulata* other than gross vegetative similarity.

While *Glandularia quadrangulata* and *G. verecunda* have largely allopatric ranges, mixed populations occur near the Pecos River and in southern Texas. In fact there are three herbarium collections at TEX-LL that contain material of both taxa: two from Upton County, Texas, 3.1 miles east of McCamey, 21 Apr 1999, *Turner 99-179* and *99-200* (TEX) and one from southern Texas, Kleberg Co., Texas; Hwy. 77, 2 mi W of Riviera, 15 Mar 1965, *Ramerez & Cardenas 78* (TEX). An additional pair of specimens from SRSC (Brewster Co., Texas, sandy soil along the Rio Grande at Boquillas, 10 May 1933, H.T. Fletcher 1224 (*G. quandrangulata*) 1226 (*G. verecunda*) were apparently collected in the same area. In vestiture, leaf size and shape the two taxa are very similar, if not identical.

The overall similarity and occasional sympatry of *Glandularia quadrangulata* and *G. verecunda* caused Turner (1998) to conclude that *G. verecunda* was only a ex-appendiculate form of *V. quadrangulata* unworthy of formal nomenclatural recognition although he presented no evidence of introgression. But we must ask, what characteristics would be expected in hybrids? Would they have intermediate appendages or no appendage at all and be identical with *G. verecunda*?

No plants have every been discovered in nature with nutlets intermediate in structure between those of *G. quadrangulata* and *G. verecunda*. All plants either have nutlets with or without the distinctive distal appendage. Furthermore, no artificial hybridization has been done to determine the condition that would be expressed in a hybrid. The pattern found with *G. quadrangulata* and *G. verecunda* presents an interesting conundrum. Are the two taxa merely forms of one other, as Turner espouses, separated by only a single character that is either expressed or not, so that hybrids would be identical to one taxon or another? Or are they two separate species that do not or seldom hybridize? Or should they be recognized at least at the infraspecific level?

It remains that the two taxa are nearly identical vegetatively and florally except for the distal nutlet appendage on *G. quadrangulata*. I concede that the

two are most-closely related or sister taxa; to think otherwise would be difficult to defend. But there seems to be a stability in their lineages as indicated by their respective large and mostly independent geographical ranges.

The genetic basis of the nutlet-appendage character is not known. If it is a simple Mendelian trait, it would appear not to have a high mutation rate. If the appendaged nutlet type in *Glandularia quadrangulata* were pleisomorphic and dominant state (i.e., AA, or Aa) and the non-appendaged nutlets represented a loss of this character (i.e., aa), then once a mutation (a) forms, or once hybridization occurs, one would expect the heteozygotic plants to form seeds at a 1:2:1 genotypic ratio (1AA:2Aa:1aa), a phenotypic ratio of 3 appendaged to 1 non-appendaged character state while the homozygous plants would breed true over successive generations. The same pattern would be expected if the appendage were a recessive character state. Whether this is occurring in certain localities is unknown. But it remains that large geographical regions are occupied by plants with either appendaged or non-appendaged nutlets indicating a low rate of mutation or hybridization. If mutation rates were higher, or hybridization more frequent, homozygous recessive traits would be expected throughout the dominant-trait populations.

Turner (1989) has treated the two taxa as unnamed forms, relegating Umber's *G. verecunda* to obscurity. But if the two taxa are facultative autogamous, they could very well become sympatric without mixing and thus behave much like species. Likewise if they are allopatric, and mutation rate is very low, again they would breed true to form and behave as species. To relegate the two taxa to unnamed forma, is not reflective of the conditions observed in nature. In typical formas, the homozygous recessive character states usually occur scattered in some or many populations, their frequency reflecting the frequency of the recessive trait. These two taxa behave more like species. They each have broad geographical ranges. The distinguishing character state is conspicuous. There is a possibility that in some populations, where both taxa are present, they may have introgressed and mixed populations are being produced through recombination. But as there is no intermediate character state, the populations would appear to be consisting of two sympatric separate taxa. If they actually are interbreeding, there would be no way to tell except by growing the nutlets out from these mixed populations to see if they breed true to form. I have visited two populations where the two taxa are sympatric, west of Riviera, in Kleberg Co., Texas and west of McCamby, in Upton Co., Texas in the late spring of 2001. In the former the roadside populations are largely being replaced by Bermuda Grass, but some nutlets were collected from scattered specimens of *G. quadrangulata*. In the Upton County populations, no plants were found presumably due to local rainfall conditions.

Of the three nomenclatural possibilities: (1) being inconsequential forms of each other; (2) being geographical subunits of a species, i.e., subspecies or

varieties of one species; or (3) being separate species that merely co-occur in some areas. I consider that the first choice is least supportable. Mixed populations are few, no plants with intermediate fruit conditions are known to exist, plants with the two fruit types occur in broad, somewhat discrete geographical ranges. This treatment would ignore the pattern of variation as it would not be reflected in the nomenclature. One could argue, just as strongly, that the two taxa are distinct species that are very similar vegetatively that can co-occur without interbreeding as no intermediates have every been found. But the lack of interbreeding may be based in autogamy more than some other type of isolating mechanism.

If there was evidence of interbreeding, they the two taxa could be recognized at the infraspecific level. But this does not exist. Therefore the two taxa will here be recognized as distinct species.

Glandularia quadrangulata (Heller) Umber (**Fig. 1 A–D**). BASIONYM: *Verbena quadrangulata* Heller, Contr. Herb. Franklin Marshall Coll. 1:84. pl. 6. 1895. TYPE: U.S.A. TEXAS. NUECES CO.: Corpus Christi, 5 Mar 1894, *Heller 1388* (HOLOTYPE: (in part) NY; ISOTYPES: GH, MO).

Verbena pumila f. *albiflora* Standl., Field. Mus. Publ. Bot. 4: 256. 1929. TYPE: U.S.A. TEXAS. BEXAR CO.: San Antonio, *L.E. Pagel 2208* (HOLOTYPE: F).

Weak-stemmed annuals 0.5–2 dm tall; stems several from the base, 1–3(–7) dm long, initially briefly decumbent, erect above, with age spreading, decumbent, ascending distally, the internodes (1.2–)2–5(–11) cm long, green to tan, sometimes purple with age, grooved on two sides when young , this obscured when larger, moderately (to strongly below inflorescence) hirtellous to pilose with slender, tapering erect, mostly straight hairs 0.2–1.2(–1.8) mm long, sometimes with stipitate glands to 0.2 mm long. Leaves ovate to ovate-rhombic in outline (12–)15–25(–38) mm long, (8.5–)10–20(–30) mm wide, usually much shorter than the internodes, with petioles 2–11 mm long, the blades 3–5 cleft about half, two-thirds way to the midrib, the clefts entire to few to strongly toothed and lobed, usually moreso on the outer margins, ultimately the leaf with 7–22 oblong to oblong-obovate, obtuse-rounded, sometimes acute lobes 1–2.5(–3.5) mm wide, the blades flat to usually somewhat concave and with impressed primary-secondary veins above, with rather stiff, tapering unicellular hairs 0.3–0.8(–1.1) mm long on both surfaces, these generally dispersed and ascending above, mostly along the yellowish raised veins and the slightly revolute margins (or ± uniformly scattered) beneath, those of the upper surface sometimes pustulate based. Spikes terminal on all branches, initially crowded with a short peduncle, 9–11 mm wide, with age the inflorescence axis elongating below, and the lowermost developing fruit becoming increasingly more remote, until separated by 5–7 mm along the axis, the inflorescences then extending 4–13 cm long with a peduncle to 5 cm long, the spike rachis ± densely pilose with hairs to 1.8 mm long; bracts ascending, linear-lanceolate, 3.2–5.5 mm long, hirsute along margins and

midvein with hairs 0.2–1.6 mm long, 59–79 percent as long as the calyx; calyces initially 5.0–6.5 mm long, membranous between the 5 green veins, hirtellous and hirsute with hairs 0.2–1.2 mm long, without or without stipitate glands, the lobes unequal, 0.4–0.8 mm long, green or purple tipped, in fruit the calyces expanding around the nutlet becoming strongly trunctated and to 2.5 mm broad at the base; corollas slaverform, the slender tubes 5.2–6.6 mm long, 0.4–0.6 mm wide at the throat, the limbs white to lavender, (2.0-)2.5–3.5(-4.5) mm wide, the 5 lobes all retuse, or the upper two lobes not retuse, 1.0–1.2 mm long, 0.5–1.3 mm wide; the tube orifice with gold-white moniliform hairs to 0.5 mm long; distal anthers 0.4–0.5 mm long, the anther gland obscure, with filaments 0.3 mm long, the proximal anthers 0.3 mm long, with filaments 0.2 mm long; style 4–5.2 mm long. Mature fruit (3.3–)3.5–4.2 mm long, the distal, adaxial, obtuse, ovate appendage 1.0–1.4 mm long, 0.8–1.0 mm wide, the central body cylindrical, 0.55–0.65 mm wide, the cream-colored commissural face 0.38–0.55 mm wide, this extending throughout the distal appendage, strongly aculeate with papillae to 0.25 mm long, the basal pericarp expanded, forming a hollow chamber to 1.0–1.6 mm wide, the outer pericarp black, shallowly reticulate in the distal half, the reticulate pattern disorganizing into vertical striae in the lower half, the post-dehiscent receptacle small, not whitish or whitish-cream.

The species is characterized by its moderate to strongly incised leaves that are relatively broad along the midvein (often cleft to only 1/3 to total width), by the small corollas, and by distinctive nutlets that have narrow central bodies, with the pericarp greatly expanding at the base, with a conspicuous, spoon-like appendage nearly 1 mm high at the tip, with the commissural face nearly as wide as the mid nutlet, continuing into the distal appendage. Relationships of the species may also lie with two other species in North america have similar nutlets with broad commissural faces: *Glandularia shrevei* (Moldenke) Umber and possibly *Glandularia bajacalifornica* (Moldenke) Umber (Umber 1979).

Widespread in southern Texas and closely adjacent Mexico also in west Texas near the Pecos River (Fig. 3), in limestone, caliche, gravelly to sandy, clayish soils in coastal prairie, thorn scrub, in cis-Pecos Texas in desertic scrub, often roadsides, open areas, 10 to 1000 m, flowering late February to April.

Glandularia verecunda Umber, Syst. Bot. 4:99. 1979. (**Fig. 1 E–H**). TYPE: U.S.A. TEXAS. REEVES CO.: 2.5 mi E of Toyah, *R. & J. Umber 379* (HOLOTYPE: GH; ISOTYPES: TEX!, NY).

Verbena pumila f. *albida* Moldenke, Phytologia 9:188. 1963. TYPE: U.S.A. TEXAS. KENEDY CO.: at the edge of Kenedy Co., Highway 96 at the Willacy Co. line, 18 Apr 1941, *Runyon 2499* (HOLOTYPE: NY; ISOTYPE: TEX!).

Vegetatively similar to *G. quandrangulata* but the leaves more ovate to obovate in outline (12–)15–25(–42) mm long, (9.5–)10–20(-25) mm wide, with petioles 4–8 mm long, the lateral clefts more often entire or with fewer lateral teeth-lobes, and the hairs more often with pustulate bases. Inflorescence bracts lin-

ear-lanceolate to lanceolate, 3.2–6.5 mm long, 49–87 percent as long as the calyces; calyces 5.5–7.0 mm long, the lobes, 0.4–1.1 mm long, in fruit the calyces to 1.7–2.5 mm broad at the base; corolla tubes 5.5–7.0 mm long, 0.5–0.9 mm wide, the limbs white to lavender, 3.2–4.5(–5.5) mm wide, the 5 lobes all retuse, or the upper two lobes not retuse, 1.4–1.8 mm long, 0.8–2.0 mm wide; the distal anthers 0.6–0.8 mm long, with filaments 0.5–0.7 mm long, the proximal anthers 0.4–0.6 mm long, with filaments 0.2 mm long; styles 5.0–5.2 mm long. Mature nutlets (2.6–)2.8–3.3 mm long, lacking a terminal appendage, the central body 0.5–0.6(–0.65) mm wide, the cream-colored commissural face 0.35–0.5 mm wide, this extending to within 0.05–0.2 of the tip of the fruit, the distal commissural surface truncate or slightly retuse, the inner tip of the fruit with a short inward pointing, tapering, horizontal appendage to 0.2 mm long, the commissural face aculeate with papillae to 0.15 mm long, the basal pericarp expanded, forming a hollow chamber to 1.0–1.3 mm wide, the post-dehiscent receptacle 1.0–1.2 mm wide, whitish-cream in color.

South Texas and trans-Pecos Texas south into eastern Chihuahua, also eastern Coahuila and adjacent Nuevo León (Fig. 3) on calcareous and limestone derived clays, sandy soils, grasslands, thorn scrub, to *Larrea*, *Acacia*, *Hectia* scrub, also disturbed flats, roadsides, milpas; 5-800 m elevation; flowering, March through May, also in Fall with rains.

The taxon is vegetatively similar to that of *G. quadrangulata* has less strong cleft leaves, slightly larger corollas, anthers, and similar nutlets that, however, lack the distinctive distal appendage.

Glandularia racemosa (Eggert) Umber, Syst. Bot. 4:99. 1979. (**Fig. 2**). *Verbena racemosa* Eggert, Torreya 2:123. 1902. TYPE: U.S.A. TEXAS. EL PASO (now Hudspeth) CO.: low sandy valley, Sierra Blanca, 15 May 1901, *H.K.D. Eggert s.n.* (HOLOTYPE: NY; ISOTYPES: GH, MO).

Verbena pulchella Greene, Pittonia 5:136. 1903. TYPE: U.S.A. TEXAS. JEFF DAVIS CO.: Foothills of the Davis Mountains, *Tracy & Earl 106a* (HOLOTYPE: ND-G?; ISOTYPES: NY, GH).

Usually thick-stemmed annuals 0.5–2.5 dm tall; stems initially several from the base, briefly decumbent and erect above, with age more spreading, decumbent, ascending distally, 1–3(–7) dm long, and the plants becoming bushy, the internodes (1.0–)2–4(–6.5) cm long, green, sometimes purple with age, 4-angled, obscurely grooved on two sides when young, moderately to strongly (below inflorescence) hirtellous to pilose with slender, tapering erect, mostly straight hairs 0.2–1.2(–1.4) mm long, sometimes with stipitate glands to 0.2 mm long below the inflorescence. Leaves opposite and in axillary clusters, broadly ovate to ovate-rhombic in outline, 11–25(–45) mm long, (6–)12–22(–26) mm wide, shorter than the internodes, with petioles 2–6 mm long, the blades 2–3 pinnatifid, deeply divided nearly to the midrib, the divisions variously revolute, oblong to lanceolate, 1–7 mm long, 0.8–1.5(–3.5) mm wide, with 7–28 ultimate, acute to obtuse lobes, the blades flat to usually conduplicate with the lobes ascend-

ing, with rather stiff, tapering unicellular hairs 0.2–0.5(–0.8) mm long on both surfaces, these generally dispersed and ascending on both surfaces, the hairs sometimes with pustulate bases, the veins impressed above, broadened beneath, the blades green to grayish due to the vestiture. Spikes terminal on all branches, 10–25(–35) mm long, 11–12 mm wide, densely crowded, the inflorscence axis seldom elongating at the base; peduncles 14–24 mm long, or the spikes closely subtended by leaves, the spike rachis ± pilose with hairs to 1.4 mm long and often with stipitate glands; bracts ascending, linear-lanceolate, 3.3–6.1 mm long, to 0.6–1 mm wide, hirsute along margins and midvein with hairs 0.2–1.1 mm long and with stipitate glands, 51–89 percent as long as the calyx; calyces initially 5–7 mm long, membranous between the 5 green veins, hirtellous and hirsute with hairs 0.2–0.8 mm long, usually with stipitate glands 0.1–0.2 mm long, the lobes unequal, 0.4–1.4 mm long, green or purple tipped, in fruit the calyces becoming trunctated and to 1.5 mm broad at the base; corollas slaverform, the tubes 6–7.5 mm long, expanding to 1.0–1.3 mm wide at the throat, the limbs white or tinged with lavender, (5.5–)6.0–9.0 mm wide, the 5 lobes all retuse, 1.6–3.5 mm long, 1.7–3.8 mm wide; the tube orifice with white or yellow moniliform hairs to 0.7 mm long; distal anterior anthers 0.6–0.8 mm long, the anther gland obscure or extending above the anthers, the filaments 0.5–0.7 mm long, the proximal posterior anthers 0.5–0.6 mm long, the filaments 0.2–0.3 mm long; style 5.5–6.2 mm long. Mature nutlets (2.0–)2.2–2.7 mm long, rounded at the tip, the central body 0.55–0.75 mm wide, the whitish commissural face 0.25–0.3(–0.35) mm wide, this rounded at the tip and extending to within 0.15–0.4 mm of the rounded nutlet tip, weakly aculeate with papillae to 0.1 mm long, the basal pericarp slightly expanded, hollow, 0.6–0.85 mm wide, the outer pericarp black, shallowly reticulate in the distal half, the reticulate pattern disorganizing into vertical striae in the lower half, the post-dehiscent receptacle yellowish, 4-angled, distinct.

Central trans-Pecos Texas (Fig. 3), mostly on limestone derived, calcareous soils, roadsides, mesquite flats, grasslands, with specimens verified from Brewster, Pecos, Hudspeth, Terrell and Reeves counties, Texas, flowering March and April, 2500–4000 ft. elevation. Moldenke 1964b sites additional specimens from Houston, Montgomery, Glasscock, Presidio, ValVerde, LaSalle counties, Texas, as well as San Miguel Co., New Mexico and the Mexican states of Coahuila and Nuevo León. His Montgomery Co., was from Stockton (= Ft. Stockton, Pecos Co., Tex.) His San Miguel Co., New Mexico was from Pecos Valley (= Pecos Co., Tex.) Others were *G. verecunda* or *G. pumila.*

The species has more strongly divided leaf blades, with the blade narrowed to 1/10 of the leaf width at the midvein, and sometimes have a denser vestiture. They have large corollas with tubes 6–7.5 mm long, and limbs 6.2–9.0 mm wide, and nutlets are shorter, rounded at the tip, not strongly expanded at the base, the commissural face is narrower than the nutlet width, and its distal surface is

rounded, not retuse, and the aculeae on the commissural face are reduced to only 0.1 mm in total length.

Glandularia racemosa is easily separated from *G. quadrangulata* and *G. verecunda*, as leaves are more deeply divided, often with a denser vestiture, the corollas limbs are larger, and the nutlets are much shorter, without a broadly outwardly flaring base, the commissural face is notably narrower than the central portion of the nutlet, and the distal portion of the commissural face is rounded, not retuse and occurs 0.15–0.3 below the rounded fruit tip. Umber (1977, 1979) notes relates this species to the *Glandularia bipinnatifida* complex, and reports hybridization between *G. racemosa* and *G. bipinnatifida* documented by mixed flavonoid profiles in the hybrids (Umber 1977).

A separate paper will deal with Turner's (1999) reclassification of the *Glandularia bipinnatifida* complex.

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Michael Bell. 2003. **The Gardener's Guide to Growing Temperate Bamboos.** (ISBN 0-88192-570-5, pbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $19.95 (pbk, 2003), 160 pp., 68 color photos, 14 b/w line drawings, 1 map, 7" × 9 1/2".

Key Words: Bamboos, history, botany, cultivation, propagation, gardening, identification.

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Key Words: Dahlia, history, cultivation, propagation, gardening.

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Table of Contents: Introduction to Grasses, Coloured-leaf Grasses, Flowering grasses, Orchestrating the Grasses, Plant Care, Appendices, Index, and Acknowledgements.

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Table of Contents: Introduction to Ferns, The Plants, Plant Care, Appendices, Index, and Acknowledgements.

THE BRACTEOLES IN *AMARANTHUS* (AMARANTHACEAE): THEIR MORPHOLOGY, STRUCTURE, FUNCTION, AND TAXONOMIC SIGNIFICANCE

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ABSTRACT

The morphology and anatomy of bracteoles were surveyed in 20 *Amaranthus* taxa in order to determine their taxonomic significance and role. Three types of bracteoles were distinguished: spinose, foliaceous and membranous. The bracteoles retain the C_4 structure of the leaves, but they differ from the latter by the presence of well-developed sclerenchyma and the arch-shaped Kranz bundle-sheath. Protection and photosynthesis are the two functions of bracteoles inferred from their structure. Based on their structure, foliaceous and membranous bracteoles are considered symplesiomorphic, while spinose bracteoles are interpreted as synapomorphic. The spines present at the base of each leaf in *A. spinosus* L. are metamorphosed bracteoles. The shortness of bracteoles in the grain amaranths (*A. caudatus* L., *A. cruentus* L. and *A. hypochondriacus* L.) was found to be a reliable character, which separates them from their wild relatives (*A. hybridus* L. and *A. powellii* S. Watson). The structure of bracteoles may be significant for recognition of taxa in only a few cases: *A. hybridus* L. and *A. powellii* S. Wats.; *A. powellii* subsp. *powellii* and subsp. *bouchonii* (Thell.) Costea & Carretero and *A. blitum* L. agg

RESUMEN

La morfología y anatomía de las bracteolas de 20 taxa de *Amaranthus* fueron examinadas para determinar su significado taxonómico y su función. Se diferenciaron tres tipos de bracteolas, espinosas, foliáceas y membranosas. Las bracteolas retienen la estructura C_4 de las hojas, pero difieren de estas últimas por la presencia de un esclerénquima bien desarrollado y en la forma arqueada de la vaina de los haces de tipo Kranz. Las dos funciones de las bracteolas son la protección y la fotosíntesis según se deduce de su estructura. Basándonos en su estructura, las bracteolas foliáceas y membranosas son consideradas como simplesiomórficas, mientras que las bracteolas espinosas son interpretadas como sinapomórficas. Las espinas presentes en la base de cada hoja de *A. spinosus* L. son bracteolas metamorfoseadas. La cortedad de las bracteolas en los amarantos cultivados como pseudocereales (*A. caudatus* L., *A. cruentus* L. y *A. hypochondriacus* L.) fue encontrada como un carácter que los separa de sus parientes silvestres (*A. hybridus* L. y *A. powellii* S. Watson). La estructura de las bracteolas puede ser significativa para el reconocimiento de taxa sólo en algunos casos: *A. hybridus* L. y *A. powellii* S. Wats.; *A. powellii* subsp. *powellii* y subsp. *bouchonii* (Tell.) Costea & Carretero y *A. blitum* agg.

INTRODUCTION

The genus *Amaranthus* is a group of extremely high economical value. Some species are grown as vegetables and pseudocereals (reviewed by Brenner et al. 2000), while others are among the most important weeds of the world (Holm et

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al. 1997). Additionally, some species are widespread ornamentals and they have a potential as forage crops and as a source of red food colorants (Cai et al. 1988). The taxonomical treatment of some species has proven to be problematic (e.g. Costea et al. 2001; Xu & Sun 2001), and it is proposed that characters of bracteoles may bring forward additional data useful for the classification of the species within this genus. Bracts are modified leaves without an axillary bud, associated with the inflorescence or with individual flowers (McCusker 1999). Bracteoles are secondary bracts borne singly (usually in monocotyledons) or in pairs on the pedicel, the calyx or the perianth of a flower (McCusker 1999). In *Amaranthus*, bracteoles should not be mistaken with the tepals. The later are the units of perianth, which is not differentiated in a calyx and a corolla (McCusker 1999). As Brenan (1961) wrote: "the size and shape of longer bracteoles in the inflorescence, and particularly their length relative to the flowers they subtend, are of great importance in distinguishing several species of the genus *Amaranthus*." In the difficult *A. hybridus* aggregate, the morphology of bracteoles has been used to differentiate grain amaranths (*Amaranthus caudatus*, *A. cruentus* and *A. hypochondriacus*) from their wild relatives (*A. hybridus* subsp. *quitensis*, *A. hybridus* subsp. *hybridus* and *A. powellii* subsp. *powellii*) (reviewed by Costea et al. 2001). The length of bracteoles has also traditionally been used to classify the infraspecific variability of some species such as *A. retroflexus* (e.g., Thellung 1914). We have proposed to reevaluate the bracteoles in *Amaranthus* in order to determine their taxonomic significance.

Amaranthus spp. are C_4 plants and, therefore, exhibit the characteristic Kranz anatomy in the leaves (best described in *A. retroflexus* by Fischer & Evert 1982) and cotyledons (Wang et al. 1993). No anatomical study of bracteoles has been published in *Amaranthus*, and it would be interesting to compare their anatomy with that of the leaves. Furthermore, the structure may indicate their function and could provide new relevant data regarding the evolution of the genus.

Amaranthus spinosus is the only species of the genus that exhibits two spines at the base of each leaf, and Thellung (1914) suggested that the two spines are actually metamorphosed bracteoles. Testing this hypothesis was another objective of this study.

MATERIALS AND METHODS

Morphology of female bracteoles was examined both on herbarium and fresh material. Only the bracteoles subtending the flowers during fructification were taken into consideration. The following herbaria collections were surveyed for the nine qualitative characteristics (see below): BH, BP, BPI, BRIT, CAS, CLA, CM, DAO, DAV, DS, DUKE, FLAS, HAM, I, IBE, ISC, LA, LIL, MICH, MIL, MIN, MO, MSC, MT, NA, OAC, OKL, PRH, QFA, RB, RSA, SMU, SOM, TEX, UCR, UMO, US, UTEP, VAB, VDB, VF and WIS. Additionally, bracteoles were collected from the wild flora (mainly from Romania and Spain) and from cultivated accessions

provided by the USDA and Gatersleben germplasm collections (Table 1). Voucher specimens are preserved in the BUAG herbarium collection, except for the USDA accessions, which are preserved in the US collection. For the anatomical study, twenty bracteoles were collected from each plant, and 15–20 different plants for each species were examined. Bracteoles were fixed in formalin-acetic acid-alcohol (5:5:90) (FAA) and embedded in paraffin. Transverse sections were made at 5–7 mm in thickness and stained with Toluidine Blue. The structure of the bracteoles varies along with their length. The most complete region is usually at the base (0.2–0.4 mm) of bracteoles, and characters refer to this region. Drawings were prepared with a Reichart camera lucida.

List of bracteole characters examined (See the results section for additional explanations.):

a) qualitative characters of bracteoles (Table 2)

1. Bracteole type:
   s, spinose;
   f, foliaceous;
   m, membranous;
2. Branching of mid-vein:
   +, branched;
   -, unbranched;
3. Pattern of mesophyll development along the bracteole's mid-vein:
   +, uniform, mesophyll more or less uniformly distributed along the mid-vein;
   -, not uniform, mesophyll is more developed in certain regions, usually at the middle or above the middle;
4. Color of the mid-vein (examined on dry material):
   g, green (usually dark-green);
   y, yellow to yellowish-brown or reddish;
5. Shape of the median part of bracteoles (vascular tissue + sclerenchyma + mesophyll) as seen in cross-sections (examined only for spinose bracteoles):
   cir, semicircular;
   el, semi-elliptic;
   de, deltoid;
   tri, trilobate;
6. Spatial pattern of Kranz bundle sheath arrangement (only for bracteoles with branched mid-veins):
   sep, Kranz sheath separately surrounds each branch of the mid-vein;
   tog, Kranz sheath encloses all the branches together;
7. Shape of "Kranz cells" as seen in cross-section:
   ro, rounded or square;
   pa, palisade like;
8. Bundle sheath:
   co+, bundle sheath in contact with the lower epidermis at least in some points;
   co-, additional layers of mesophyll are present between the bundle sheath and the lower epidermis;
9. Mesophyll cells (when present):
   pa, palisade-like;
   spo, spongy parenchyma-like;
   tan, tangentially elongated;

TABLE 1. Provenance of *Amaranthus* taxa (Amaranthaceae) examined for anatomy of bracteoles (Germany* = accessions from Gatersleben).

Taxa	Voucher no. or accession	Provenance
Subgenus *Acnida* (L.) Aellen ex K.R. Robertson		
A. palmeri S. Wats.	23522 (a–j)	Romania
Subgenus *Amaranthus* (= section Amaranthus)		
A. caudatus L.	23050 (a–j)	Romania
	(k–s)	Germany*
	Ames 2026	Nepal
	PI 16604	India
	PI 490440	Peru
A. cruentus L.	23037 (a–j)	Romania
	PI 566896	Arizona, USA
	PI 566897	India
	PI 511919	Guatemala
A. hypochondriacus L.	22769 (a–j)	Romania
	(k–s)	Germany*
	PI 511721	Mexico
A. powellii S. Wats. subsp. *powellii*	22770 (a–j)	Romania
	(k–s)	Spain
A. powellii subsp. *bouchonii* (Thell.) Costea & Carretero	23041 (a–j)	Romania
	(k–s)	Spain
A. hybridus L. subsp. *hybridus*	22721 (a–j)	Romania
	(k–s)	Spain
A. hybridus subsp. *quitensis* (Thell.) Costea & Carretero	22840 (a–j)	Romania
	(k–s)	Germany*
A. spinosus L.	23566 (a–j)	Germany*
A. retroflexus L.	21822 (a–j)	Romania
	(k–s)	Spain
Subgenus *Albersia* (Kunth) Gren. & Godr. (= Section Blitopsis Dumort.)		
A. albus L.	21800 (a–j)	Romania
	(k–s)	Spain
	Ames 13788	Canada
A. blitum L. subsp. *blitum*	23049 (a–j)	Romania
	(k–s)	Germany*
A. blitum subsp. *oleraceus* (L.) Costea	23051 (a–s)	Germany*
	PI 606281	Bangladesh
A. emarginatus Moq. ex Uline & Bray	22996 (a–j)	Romania
= *A. blitum* subsp. *emarginatus* (Moq. ex Uline & Bray)	(k–s)	Spain
Carretero, Munoz Garmendia & Pedro	Ames 23387	Brazil
	Ames 14964	India
A. viridis L.	23034 (a–j)	Romania
	(k–s)	Spain

TABLE 1. continued

Taxa	Voucher no. or accession	Provenance
A. blitoides S. Wats.	23045 (a–j)	Romania
	(k–s)	Spain
	PI 553 059	Canada
	PI 608 663	USA
A. crispus (Lesp. & Thev.) N. Terraciano	22225 (a–j)	Romania
A. deflexus L.	22228 (a–j)	Romania
	(k–s)	Spain

10. Sclerenchyma (only for bracteoles with branched mid-veins):
com, compact, enclosing all the vascular tissue;
frag, fragmented, separately accompanying each vein;
11. Base of the wings containing:
m+s, with mesophyll + sclerenchyma;
m, only with mesophyll;
s, only with sclerenchyma;
-, neither mesophyll nor sclerenchyma is present:

b) quantitative characters of bracteoles (Table 3)

1. Length (mm);
2. Maximum width at the base (mm);
3. Length of the spinose apex—only for spinose bracteoles (μm);
4. Angle between wings and the median part;
5. Thickness at the base (measured on cross-sections) (μm);
6. Thickness of the collateral bundle or of the main collateral bundle in the case of branched mid-veins (μm);
7. Thickness of mesophyll (μm);
8. Thickness of bundle sheath cells (μm);
9. Ratio: bracteoles length/ perianth length.

RESULTS

In all the species examined, each flower is subtended by two bracteoles (sometimes only one, or up to four) which are more or less modified compared to the leaves. The bracteoles in *Amaranthus* can be classified as follows:

a) *Spinose bracteoles* (Fig. 1, A–F; Fig. 3A).—Are rigid and have a spiny tip. They have a median part that includes the mid-vein surrounded by sclerenchyma and mesophyll, and two membranous lateral parts that we shall name "wings," due to of their membranous appearance. The sclerenchyma is more developed than the mesophyll, conferring the hard and rigid appearance of bracteoles. As seen in cross-sections, the median part can be semicircular (Fig. 1C, E) semi-elliptic (Fig. 1D), deltoid (Fig. 1B, F) or even trilobed (Fig. 2A) (Table 2). The wings are not arranged in the same plane with the median part. They form a characteristic angle with the median part, which is maintained even in cross-sections (Table 3). Representative species: *Amaranthus powellii* (Fig. 1E).

TABLE 2. Data matrix for qualitative characters in some species of the genus *Amaranthus* (Amaranthaceae). See "material and methods" for the numbered characters; na = not aplicable.

Taxa/Character	1	2	3	4	5	6	7	8	9	10	11
A. palmeri	s	+	+	g	de	tog	na	na	spo	com	s, m+s
A. caudatus	s	-	+	y	cir	na	ro	co-	spo	na	m
A. cruentus	s	-	+	y	el	na	ro	co-	spo	na	m+s
A. hypochondriacus	s	-	+	y	cir	na	pa	co-	pa	na	m
A. powellii subsp. *powellii*	s	-	+	y	cir	na	pa	co-	pa	na	m
A. powellii subsp. *bouchonii*	s	-	+	y	de	na	ro/pa	co+	spo	na	m+s
A. hybridus subsp. *hybridus*	s	-	+	g	de	na	ro	co-	tan	no	m+s
A. hybridus subsp. *quitensis*	s	-	+	g	de	na	ro	co-	tan	no	m+s
A. spinosus	s	+	+	g	dir	tog	na	na	spo	com	s, m+s
A. retroflexus	s	-	+	y	cir/de	na	ro/pa	co+	spo	na	s, m+s
A. albus	s	-	+	y	de/tri	na	ro	co-	pa	na	m
A. blitum subsp. *blitum*	f/m	-	-	g	na	na	ro	co-	spo	na	na
A. blitum subsp. *oleraceus*	f	+	-	g	na	sep	ro	co-	spo	sep	na
A. blitum subsp. *emarginatus*	m	-	-	g	na	na	ro	co+	na-spo	na	na
A. viridis	f/m	-		g	na	na	ro	co-	spo	na	na
A. blitoides blitoides	f	+	-	g	na	sep/tog	ro/pa	co	spo	com	na
A. crispus	m		-	g	na	na	ro	co+	na-spo	na	na
A. deflexus	m	-	-	g	na	na	ro	co+	na-spo	na	na

b) *Foliaceous bracteoles* (Fig. 2C–F).—Resemble more a small leaf, and they do not exhibit an obvious differentiation between the median and lateral parts. The mesophyll is more developed than the sclerenchyma, and as a result, the bracteoles are mostly green. The wings are narrow. Representative species: *A. blitoides* (Fig. 2E–F).

c) *Membranous bracteoles* (Fig. 2B).—Resemble the foliaceous bracteoles, but the mesophyll is poorly developed, restricted along the mid-veins, and is often reduced to the one-layered bundle-sheath. Sclerenchyma is also scarcely developed. The rest of the bracteole is thin, and membranous (as in the wings of the spinose bracteoles). Representative species: *A. crispus*. Transitional forms between the foliaceous and the membranous types occur in several species (*A. blitum* subsp. *blitum* and *A. viridis*).

The structure of bracteoles is simple: they have a dorsiventral structure, and they are composed of epidermis, mesophyll, vascular tissue and sclerenchyma. The marginal-meristem activity is intense; its cells proliferate as monolayers

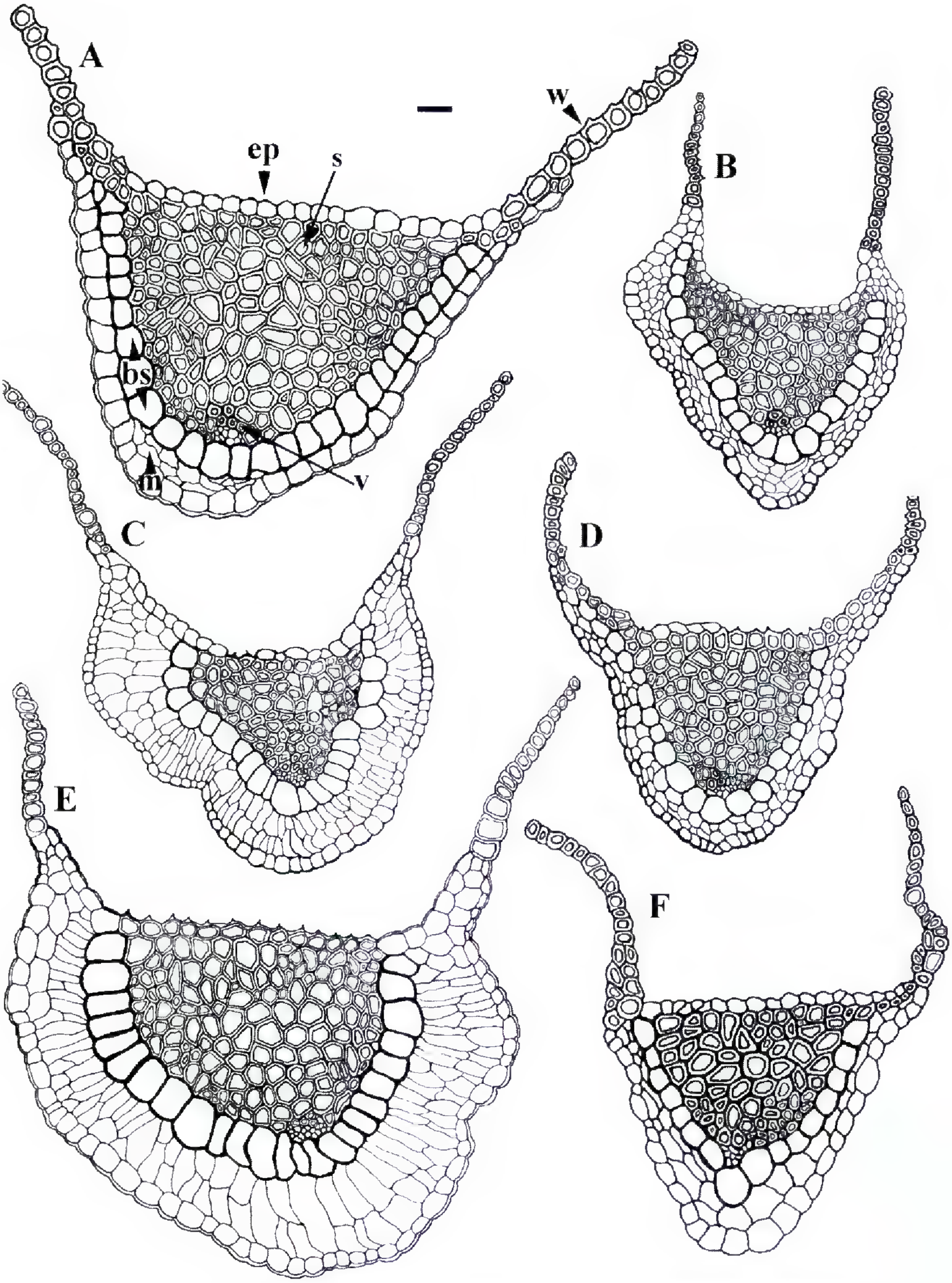


FIG. 1. Structure of spinose bracteoles. **A.** *Amaranthus retroflexus*, **B.** *A. hybridus* (incl. ssp. *quitensis*), **C.** *A. hypochondriacus*, **D.** *A. cruentus*, **E.** *A. powellii* ssp. *powellii*; **F.** *A. powellii* ssp. *bouchonii*. bs-kranz bundle-sheath, ep-epidermis, m-mesophyll, s-sclerenchyma, v-vascular tissue (collateral bundle), w-wing. Scale bar = 20 μm.

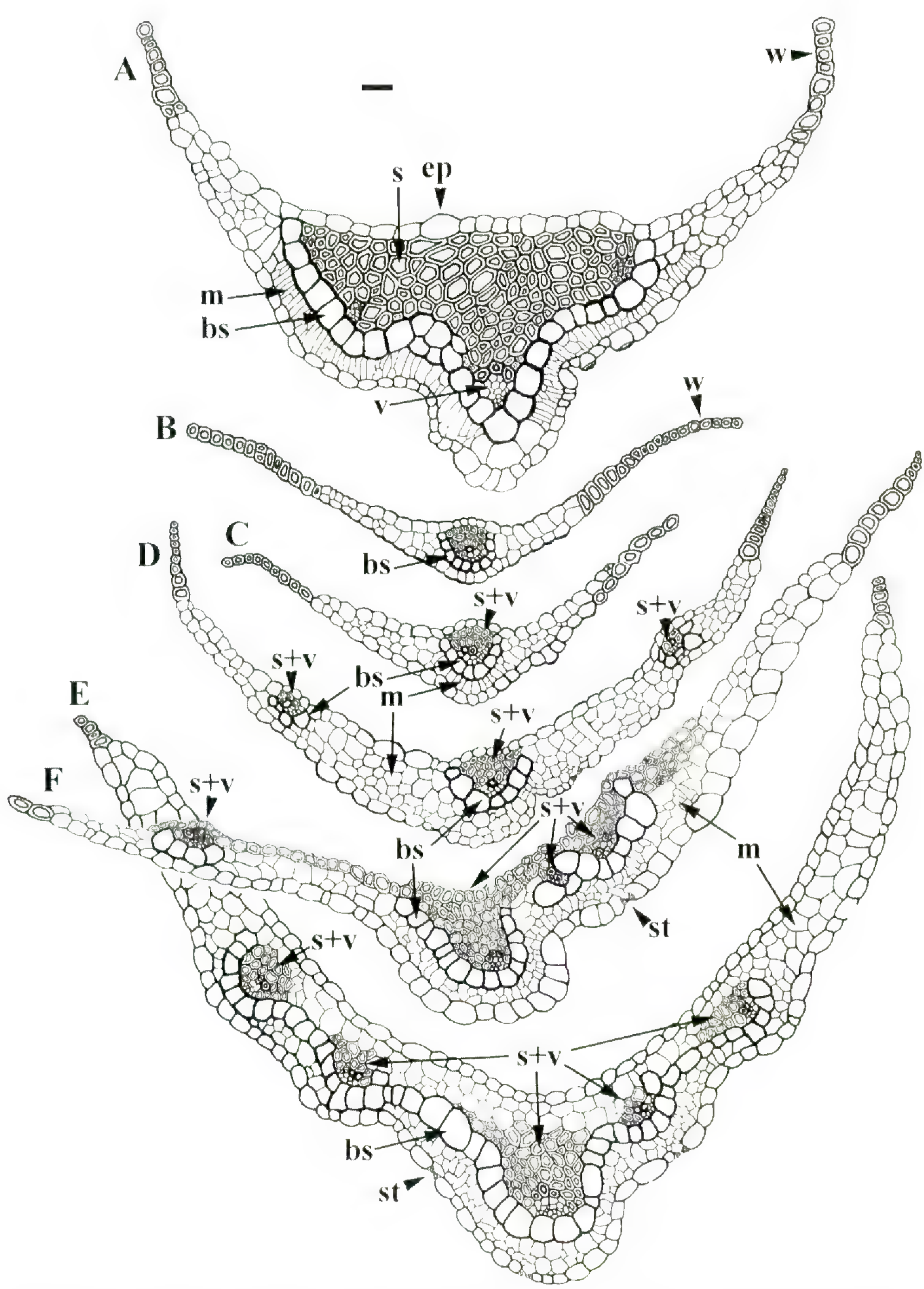


Fig. 2. Structure of bracteoles. **A.** spinose in *Amaranthus albus*, **B.** membranous in *A. blitum* ssp. *emarginatus*, **C–F** foliaceous in: **C.** *A. blitum* ssp. *blitum*, **D.** *A. blitum* ssp. *oleraceus*, **E–F.** *A. blitoides*, **E.** sectioned at the middle, **F.** sectioned at the base. bs-kranz bundle-sheath, ep-epidermis, m-mesophyll, st-stomata, s-sclerenchyma, v-vascular tissue (collateral bundle), w-wing. Scale bar = 20 μm.

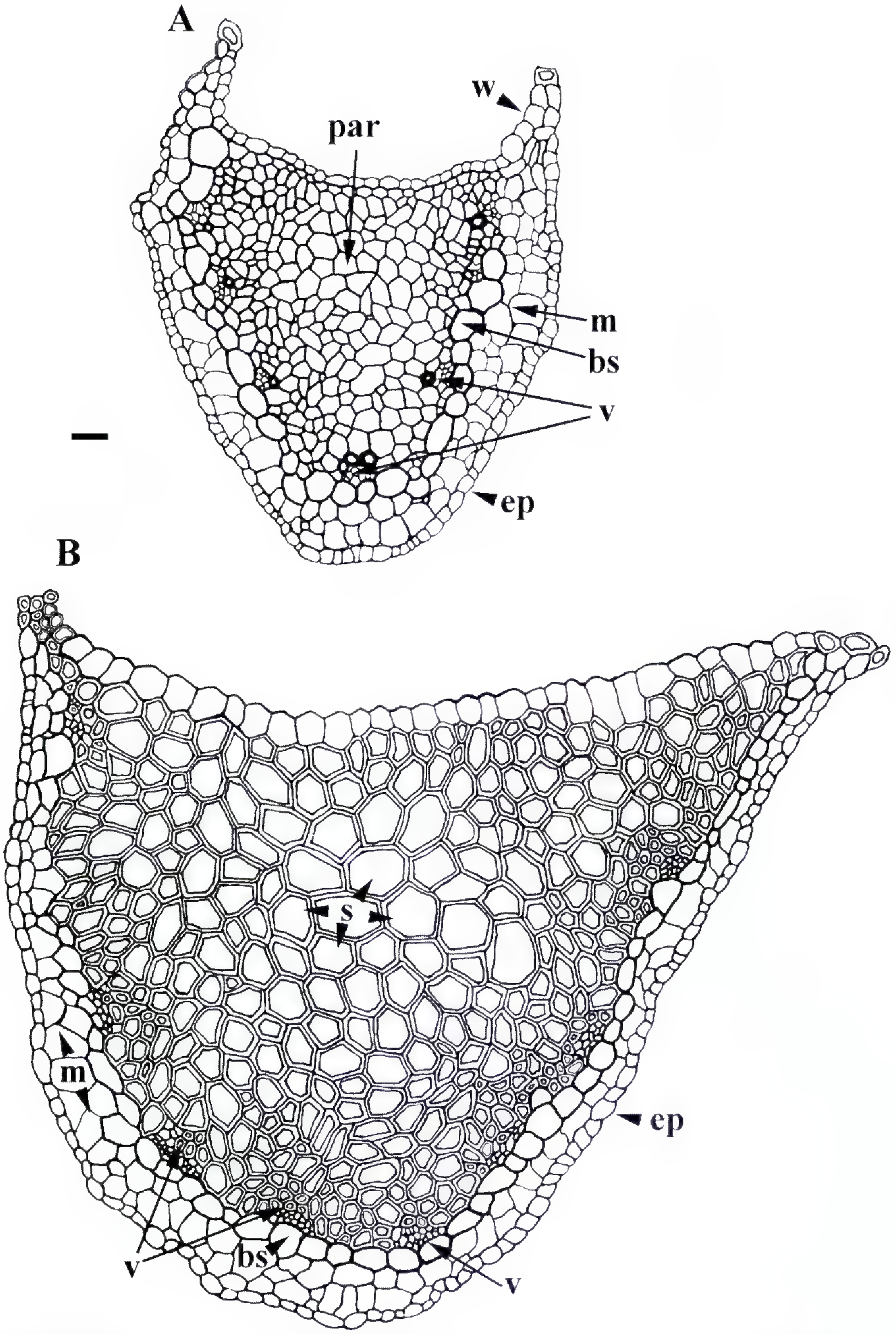


FIG. 3. Structure of spines in *Amaranthus spinosus*. **A.** early stage, bracteole-like, **B.** mature spine. bs-kranz bundle-sheath, ep-epidermis, m-mesophyll, par-parenchyma, s-sclerenchyma, v-vascular tissue (collateral bundle), w-wing. Scale bar = 20 μm.

TABLE 3. Data matrix for the quantitative characteristics of bracteoles in some *Amaranthus* taxa (Amaranthaceae). See materia and methods for numbered characters.

Taxa/Character	1	2	3	4	5	6	7	8	9
A. palmeri	5.5 + 1	1.4 ± 0.1	2.5 ± 0.5	135 ± 5	320 ± 20	300 ± 25	22.5 ± 2.5	22.5 ± 2.5	1.3–2.1
A. caudatus	3.25 ± 1.75	0.47 ± 0.1	0.67 ± 0.1	137.5 ± 2.5	215 ± 30	155 ± 15	55 ± 5	22.5 ± 2.5	1.2–1.5
A. cruentus	2.25 ± 0.25	0.95 ± 0.1	0.65 ± 0.5	135 ± 5	175 ± 25	125 ± 5	50 ± 10	22.5 ± 2.5	1–1.25
A. hypochondriacus	3.5 ± 0.5	1.2 ± 0. 25	1 ± 0.15	135 ± 5	210 ± 10	160 ± 10	100 ± 20	20 ± 15	1.25–1.6
A. powellii subsp. *powellii*	6.5 ± 1.5	2.4 ± 0.25	2.5 ± 0.5	132.5 ± 7.5	320 ± 20	210 ± 10	100 ± 10	55 ± 5	2–3
A. powellii subsp. *bouchonii*	4.25 ± 0.75	1.15 + 0.25	1.2 ± 0.3	127.5 ± 7.5	175 ± 25	122.5 ± 12.5	40 ± 20	22 ± 2.5	2–2.2
A. hybridus subsp. *hybridus*	3.75 + 1.15	1.15 ± 0.25	1 ± 0.2	95.5 ± 5	165 ± 15	110 ± 10	45 ± 5	22 ± 2.5	1.2–2
A. hybridus subsp. *quitensis*	3.75 ± 0.75	1.10 ± 0.23	0.67 ± 0.5	95 ± 5	165 ± 15	110 ± 10	45 ± 5	22 ± 2.5	1.2–2
A. spinosus	3.6 ± 0.9	1.25 ± 0.25	1.02 ± 0.27	105 ± 15	270 ± 30	220 ± 20	71 ± 11	21 ± 2.2	1.5–2
A. retroflexus	5.25 ± 1.25	1.3 ± 0.5	2.17 ± 0.17	135 ± 5	230.5 ± 30.5	203 ± 6	25 ± 25	20 ± 15	1.1–2.8
A. albus	4.2 ± 1.8	1.12 ± 0. 22	1 ± 0.2	165 ± 5	240 ± 20	162.5 ± 12.5	76.5 ± 4	20 ± 15	2–2.5
A. blitum. subsp. *blitum*	1.03 ± 0.25	0.75 ± 0.15	-	-	56 ± 6	32 ± 2	32.5 ± 7.5	12.5 ± 2.5	0.6–0.9
A. blitum subsp. *oleraceus*	1.25 ± 0.35	0.8 ± 0.1	-	-	80 ± 10	37.5 ± 2.5	45 ± 5	16.5 ± 1	0.6–0.9
A. blitum subsp. *emarginatus*	0.5 ± 0.1	0.45 ± 0.5	-	-	42.5 + 7.5	26 ± 4	12. 5 ± 12.5	10 ± 1.4	0.4–0.7
A. viridis	0.62 ± 0.7	0.5 ± 0.1	-	-	45 ± 5	22.5 ± 2.5	25 ± 2.5	12.5 ± 2.5	0.6–0.9
A. blitoides	2.15 ± 0.15	1.65 ± 0.34	-	-	177.5 ± 12.5	74 ± 12.8	76 ± 5	32.7 ± 2.4	0.8–0.95
A. crispus	1 ± 0.1	0.45 ± 5	-	-	42.5 ± 12.5	30.5 ± 11	10 ± 10	9 ± 1.1	0.6–0.9
A. deflexus	1.15 ± 0.5	0.8 ± 0.1	-	-	52.5 ± 7.5	32.5 ± 2.5	17.5 ± 17.5	12.5 ± 2.5	0.73–0.95

and give rise to the wings. Venation is poor, but the vascular tissue is accompanied by well-developed sclerenchyma. Particularly the lower epidermis may have anomocytic stomata, with three to six neighboring cells surrounding the guard cells. Sparse, multicellular, uniseriate trichomes may occur in all species, especially toward the base of the bracteoles. The vascular tissue consists of a single colateral bundle surrounded by sclerenchyma and a bundle sheath. In some of the species examined—*A. spinosus*, *A. palmeri*, *A. blitoides* and *A. blitum* subsp. *oleraceus*—the mid-vein branches (Fig. 2D–F; Table 2). In all species, the bundle sheath exhibits the "Kranz syndrome" characteristic of the leaves. The fundamental difference is that the bundle-sheath is incomplete, with the cells arranged in an arc around the sclerenchyma. The bundle sheath cells are tightly packed together, they have thicker walls, and their chloroplasts are larger than those of the mesophyll cells. In the species with bracteoles possessing a branched mid-vein, the "Kranz" bundle sheath can separately follow each branch (*A. blitum* subsp. *oleraceus*, Fig. 2D), or it can enclose all the branches together (*A. palmeri* and *A. spinosus*, Fig. 3A). In *A. blitoides* both situations may be encountered in the same bracteole: the Kranz bundle-sheath may be continuous at the base of the bracteoles (Fig. 2E) and fragmented above their middle (Fig. 2F). The mesophyll is homogenous and distributed only along the abaxial face. Its cells, arranged in up to four layers, can be palisade-like (Fig. 1C, E; Fig. 2A), spongy parenchyma-like (e.g. Fig. 1D) or, tangentially elongated (e.g. Fig. 1B) (Table 2). The mesophyll can be uniformly distributed along the mid-vein, or the mesophyll may develop preponderantly along certain regions of the bracteoles (usually in the middle and above). In the first case, the mid-vein morphologically appears "constant," gradually decreasing along its course towards the apex. In the second case, the mid-vein appears enlarged above the middle of the bracteoles. The sclerenchyma in spinose bracts is strongly developed, compact, engulfing the mid-vein and, when present, its secondary branches (e.g. in *A. spinosus* and *A. palmeri*). In foliaceous and membranous bracts with branched veins, sclerenchyma can be compact or fragmented, separately accompanying each branch (Fig. 2D) (Table 2). The wings have several layers of cells at their base and they are one-layered in the rest. The base of the wings may exhibit only mesophyll cells, only sclerenchyma, mesophyll and sclerenchyma cells or none one of these (Fig.1; Table 2). The monolayer of wings has thickened cell walls and may contain calcium oxalate crystals.

Origin of spines in Amaranthus spinosus.—This study supports Thellung's (1914) hypothesis. The two spines present at the base of each leaf are the metamorphosed bracteoles of the first flower within the first dichazial cyme, whose development is suppressed. No floral rudiments were observed in the vicinity of the developing spines which indicates that the suppression is achieved very early in the ontogeny. In an incipient stage of development, spines are similar to bracteoles (Fig. 1A). However, in bracteoles, the development of sclerenchyma

is rapidly completed. The growth of spines involves primarily cell expansion. Sclerosis is delayed until the parenchyma cells enlarge up to five times compared to the parenchyma cells of the bracteoles. Only then is the development of sclerenchyma completed (Fig. 3B). The marginal meristems make at most a limited contribution to the development of the spines, and consequently the wings are reduced or entirely absent (Fig. 3A, B). Mesophyll is present at least towards the base of spines and the vascular supply is similar to that of the bracteoles (Fig. 3B). *Amaranthus spinosus* has a form—f. *inermis* Lautersbach and Schumann—that has no spines, or with spines that are bracteole-like, subtending the first dichazial cyme of each leaf. We believe this form can be regarded as the ancestral type, from which the spiny plants derived. We observed a similar tendency of bracteoles' transformation in some individuals of *A. powellii*. However, the degree of sclerenchyma development never attains the levels observed in *A. spinosus*, and the process is not accompanied by the developmental suppression of the first cyme.

DISCUSSION

Taxonomic significance of bracteoles.—Taking into account the foliar origin of bracteoles, their phylogeny can be speculated upon. The primitive condition in *Amaranthus* is represented by the foliaceous and membranous bracteoles, while the spinose bracteoles can be considered a synapomorphy. Consequently, the most primitive *Amaranthus* species are those classified in the subgenus *Albersia*, while those from the subgenus *Amaranthus* are more evolved. This hypothesis is also supported by the evolution of other characteristics such as the dehiscence-indehiscence of fruits (Costea et al. in press) and the vascular system (Costea & DeMason 2001).

Based on the populations and accessions used, only a few of the taxonomically difficult species with spinose and foliaceous bracteoles could be separated using anatomical characteristics. Furthermore, such characteristics are even less significant in the species with membranous bracteoles, due to their extreme reduction. The anatomic differences between grain amaranths and their wild relatives are minute (Table 2, 3; Fig. 1), and it is possible that these differences will be found to be even less significant when more accessions are examined. There are no differences between *A. hybridus* subsp *hybridus* and *A. hybridus* subsp. *quitensis* which are considered different species by some authors (e.g. Xu & Sun 2001). In the *A. hybridus* agg., Townsend (1988) and Stace (1997) consider the names *A. powellii* and *A. hybridus* as taxonomic synonyms. Even if other morphological characters can easily differentiate these taxa, the distinctiveness of their bracteole anatomy supports their separate recognition (Fig.1 D-E; Table 2, 3). Another taxonomic controversy exists between *A. powellii* and *A. bouchonii* (reviewed by Costea et al. 2001). The morphologic and anatomic differences between their bracteoles support the recognition of *A. bouchonii* as

an infraspecific taxon of *A. powellii* (Costea et al. 2001) (Fig. 1 E–F; Table 2, 3). In *Amaranthus blitum* agg., the three subspecies—subsp. *blitum*, subsp. *oleraceus* and subsp. *emarginatus* are dissimilar with respect to anatomy of the bracteoles:

1. Mid-vein of (foliaceous) bracteoles branched _____ **A. blitum** subsp. **oleraceus** (Fig. 2D)
1. Mid-vein of bracteoles unbranched.
   2. Bracteoles foliaceous (rarely membranous). Cells of the Kranz bundle sheath are separated by the cells of the lower epidermis by a 1–2 layered mesophyll _____ **A. blitum** subsp. **blitum** (Fig. 2C)
   2. Bracteoles membranous. Cells of the Kranz bundle sheath are in contact with the cells of the lower epidermis (mesophyll is absent) _____ **A. blitum** subsp. **emarginatus** (Fig. 2B)

The length of bracteoles and the ratio between bracteole and tepal lengths have been used in the past to classify the infraspecific variability of some *Amaranthus* species (e.g. Thellung 1914; Brenan 1961). For example, the individuals with short bracteoles (equaling the flower perianth) were designated as var. *delilei* (Rich. & Lor.) Thell. in *A. retroflexus*. Such forms are not encountered at the population level, presumably because the short bracteole type is selected against. Based on our current knowledge, such plants cannot even be considered ecophenes, because the shortness of bracteoles can hardly be associated with any ecological advantage. In contrast, the morphology of the bracteoles is one of the few characters that differentiate the grain amaranths (especially *Amaranthus caudatus* and *A. cruentus*) from their wild relatives *A. hybridus* (incl. *A. quitensis*) and *A. powellii*. Thus, the spinose bracteoles of grain amaranths are shorter and thinner compared to those in their wild relatives. This may seem a contradiction with the previous conclusion, but in this particular case the morphology of the bracteoles is important. Domestication of grain amaranths goes back in time more than 7000 years (Sauer 1993), and this character—even if quantitative—is probably genetically fixed. The shorter and softer-spined bracteoles were selected for under domestication because they facilitate harvesting. The survey of many herbarium specimens revealed that cultivated grain amaranths consistently have short bracteoles. Only some specimens of *A. hypochondriacus* may exhibit long bracteoles (comparable with those of *A. powellii*), similarly as in *A. retroflexus* some individuals may have short bracteoles. The distinctiveness of grain amaranths is also supported by morphological (Costea et al. 2001), anatomical (Costea & DeMason 2001), cytological (reviewed by Greizerstein et al. 1997) and molecular data (Xu & Sun 2001).

Bracteoles versus foliage leaves in Amaranthus.—In many plants (e.g., *Chrysosplenium* spp., *Euphorbia* spp., *Melampyrum* spp., Costea unpublished) a continuous morphological and structural transition occurs between foliage leaves and bracts on the same plant. In amaranths, such a transition does not exist. Bracteoles in amaranths are sharply differentiated from the leaves. Several tissues of bracteoles show a reductive tendency. Bracteoles have fewer stomata,

their mesophyll and vascular tissue are less developed, and the Kranz bundle sheath is incomplete. In addition to this developmental abbreviation, formation of new structures without a counterpart in leaves occurs. An example is the sclerenchyma that is absent in *Amaranthus* leaves (e.g. Fisher & Evert 1982; Viana 1993; Esparza-Sandoval et al. 1996), but is an important tissue in the bracteoles. Marginal-meristem activity is intense, giving rise to the one-layered membranous wings, which are also absent from the leaves.

Based on their structure, *Amaranthus* spp. leaves belong to a variant of the Atriplicoid type, having a continuous Kranz sheath around the bundles (reviewed by Dengler & Nelson 1999). However, in the bracteoles, the organization of the Kranz cells in arcs is entirely different from this type, and it calls to mind other C_4 leaf structures described in *Chenopodiaceae* such as the kochioid and solsoid types (reviewed by Dengler & Nelson 1999; Jacobs et al. 2001). Since bracteoles are ontogenetically abbreviated leaves, one cannot refrain from speculating on the old idea that "ontogeny recapitulates phylogeny" (See Gould 1977). It is a fact that *Amaranthus* shares close morphological, structural (Costea & DeMason 2001) and molecular affinities with Chenopodiaceae (reviewed by Cuénoud et al. 2002) and these new data provide additional evidence in this respect.

Functions of bracteoles in amaranths.—Two functions can be inferred from the structure of bracteoles in *Amaranthus*: photosynthesis and protection. Bracts (in general) are metamorphosed leaves. Although the degree of modification varies in different genera and families, the other functions of the bracts are subsequently added to the primordial role of photosynthesis. When present, bracts may participate in the development of flowers, fruits and seeds. For example, the contribution of bracts to the achene maturation in *Carpinus* spp. (Hori & Tsuge 1993) or to the development of buds in *Gossypium* spp. (Zhao & Oosterhuis 1999) was found to be significant. Studies made on *Gossypium* spp. showed that the removal of bracts reduced the cotton-boll size and the number of seeds per boll (e.g. Bangal et al. 1985; Ahmed 1994). Similar results—a lower seed yield—were reported after removing the phyllaries from the antodia of *Carthamnus tinctorius* and *Helianthus annuus* (e.g. Dhopte & Lall 1981; Hayashi & Hanada 1986). In *Amaranthus*, due to the huge number of flowers that develop in the inflorescences, the photosynthetic role of bracteoles should not be underestimated. A single plant of *Amaranthus retroflexus* can produce approximately 1 000 000 seeds (Hanf 1983). Assuming that the number of female flowers in the inflorescence is at least equal to the number of produced seeds, this would mean there are at least 2 million bracteoles in one inflorescence. Therefore, photosynthesis in bracteoles may significantly contribute to the development of the enormous number of small seeds and consequently to the ecological success of amaranths, especially as weeds. However, this hypothesis needs to be verified and the contribution of bracteoles to total photosynthesis to be established.

In many plants, protection is the most common function acquired by bracts,

which is performed in a multitude of ways, against a multitude of factors. Protection can be limited to the inflorescence and flowers, or it can also be extended to the developing fruits as well. In *Heliconia* the liquid produced in the bracts contributes to the protection against herbivores (Wooton & Sun 1990). Association with ants as a result of extrafloral nectaries developed on bracts provides a defense mechanism against a wide variety of predators (e.g. Scott 1981; McLain 1983). In *Rheum nobile*, an alpine plant, bracts absorb UV radiation and keep the reproductive organs warm (Omori et al. 2000). Mechanical protection of both flowers and fruits against herbivores is obvious for the spinose bracteoles in *Amaranthus*. There seems to be a correlation between the presence of spinose bracteoles and the dehiscence of fruits: species with dehiscent fruits have spinose bracteoles, while species with indehiscent fruits have membranous or foliaceous bracteoles (although a few exceptions exist). One of these exceptions is *A. powellii* subsp. *bouchonii* that has indehiscent fruits and spinose bracteoles. Yet, this taxon has shorter and thinner bracts compared to *A. powellii* subsp. *powellii*, its closest relative with circumscissile fruits (Costea et al. 2001). Furthermore, in monoecious and some dioecious species (e.g. *A. palmeri*) the bracteoles of the female flowers are more developed than the bracteoles of the male flowers. The abortive female flowers of hybrids are subtended by longer (than normally) bracteoles (Brenner, unpublished).

In conclusion, based on the populations and accessions examined, bracteoles are important for the species delimitation in *A. hybridus* agg. and for the separation of subspecies in *A. blitum*. The anatomical study of bracteoles, along with other characters (the vascular system and the structure of fruits) indicates that subgenus *Albersia* has a basal phylogeny within *Amaranthus*, while the species of the subgenus *Amaranthus* are derived. Protection and photosynthesis are the main functions deduced from the structure of the bracteoles.

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NOMENCLATURAL CHANGES IN THE GENUS *POLYGONUM* SECTION *POLYGONUM* (POLYGONACEAE)

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ABSTRACT

Five new combinations are proposed in the genus *Polygonum* s. str. for the forthcoming treatment of Flora of North America: *P. aviculare* subsp. *buxiforme*, *P. fowleri* subsp. *hudsonianum*, *P. humifusum* subsp. *caurianum*, *P. ramosissimum* subsp. *prolificum* and *P. striatulum* var. *texense*. The taxonomy of each taxon is briefly discussed and a diagnostic table is provided for the subspecies of *Polygonum aviculare*.

RESUMEN

Se proponen cinco nuevas combinaciones en el género *Polygonum* para el futuro tratamiento de este género en la Flora de Norteamérica: *P. aviculare* subsp. *buxiforme*, *P. fowleri* subsp. *hudsonianum*, *P. humifusum* subsp. *caurianum*, *P. ramosissimum* subsp. *prolificum* y *P. striatulum* var. *texense*. La taxonomía de cada taxon se discute brevemente y se incluye una tabla diagnóstica para las subespecies de *Polygonum aviculare*.

INTRODUCTION

During the preparation of *Polygonum* s. str. for Flora of North America it was concluded that several new combinations are required to reflect the new taxonomic knowledge in this genus. The changes involve *P. buxiforme* Small, *P. hudsonianum* (Wolf & McNeill) Hinds, *P. caurianum* Robinson, *P. prolificum* (Small) Robinson and *P. texense* M.C. Johnston.

1. Polygonum aviculare complex

Polygonum aviculare is a taxonomically controversial polyploid complex of predominantly selfing annuals. Lindman (1912) recognized two species: *P. heterophyllum* (= *P. aviculare* subsp. *aviculare*) and *P. aequale* (= *P. aviculare* subsp. *depressum*), while Chrtek (1956) accepted only one species, *P. aviculare*, with several subspecies. However, European and North American taxonomists have frequently recognized several distinct species within this complex: *P. aviculare* s.str., *P. arenastrum* Boreau, *P. boreale* Lange, *P. rurivagum* Jord. ex Boreau, *P. neglectum* Besser and *P. buxiforme* Small (e.g. Styles 1962; Mertens & Raven 1965; Scholz 1977; Wolf & McNeill 1986). The recognition of the former four species has been mainly based on Styles (1962) who studied British popu-

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lations. Styles (1962) found these four species to be morphologically discontinuous and with different chromosome numbers: *P. aviculare* and *P. rurivagum* were hexaploids (2n = 60), while *P. boreale* and *P. arenastrum* were tetraploids (2n=40). Studies done in North America initially confirmed these observations and the recognition of these species relied heavily on these different chromosome numbers (e.g. Mertens & Raven 1965; Moore et al. 1970; McNeill 1981). More recent studies have challenged both the morphological and the cytological criteria. Multivariate analysis and isoenzyme studies using many populations have proved that these taxa are not well-differentiated and populations with intermediate characteristics may occur (Meerts et al. 1990). Other chromosome counts, obtained both in Europe and North America, reported hexaploid populations among *P. arenastrum* and tetraploids among *P. aviculare* (e.g. Gasquez et al. 1978; Wolf & McNeill 1987; Meerts et al. 1998). Isoenzyme studies showed that the *P. aviculare* complex has probably an allopolyploid origin (Meerts et al. 1998) and it has evolved as a swarm of inbreeding lines ("Jordanons") (Gasquez et al. 1978). Yurtseva (2001) suggested that the patterns of variation in the pericarp surface support the hybrid origin of some species. For example, *P. arenastrum* presumably originated as a hybrid between *P. aviculare* and *P. calcatum* (= *P. aviculare* subsp. *depressum* in this study). *Polygonum neglectum* resulted from the hybridization of *P. aviculare* and *P. arenastrum*. Although the members of *P. aviculare* are predominantly inbreeders, some structures that make possible cross-pollination in other Polygonaceae are present here as well. Cleistogamous and chasmogamous flowers, the heterostyly, protandry, and the capacity to secrete nectar may be regarded as remnants of an ancestral mixed mating system (Costea and Tardif, unpublished). Bugg et al. (1987), Yurtseva (1998) reported that flowers of *P. aviculare* agg. are frequently visited by insects and thus introgression may occur to some extent. This would explain the complex intermediate variation patterns that occur between its members. In such conditions, recognition of these taxa at species level is unrealistic and unpractical. The subspecific rank is proposed for *P. buxiforme* because of the intermediates observed mainly with *P. aviculare* subsp. *aviculare*.

Polygonum aviculare L. Sp. Pl.:359. 1753 subsp. **buxiforme** (Small) Costea & Tardif, comb. et stat. nov. (**Fig. 1.**). BASIONYM: *Polygonum buxiforme* Small, Bull. Torrey Bot. Club 33:56. 1906. *Polygonum littorale* auct., non Link; *Polygonum aviculare* var. *littorale* auct., non Mertens & Koch; TYPE: U.S.A. VIRGINIA. LEE CO.: about Cumberland Gap, 27 Jul 1892, *J.K. Small s.n.* (LECTOTYPE formally designated here, Katz & McNeill, in herb 1988, NY 323754!).

Polygonum buxiforme f. *montanum* Brenckle, Phytologia 3:363. 1950.

Polygonum aviculare includes at least six subspecies in North America, which are distinguished only by a combination of characters (Table 1). Some extensively employed characters may be misleading if not examined properly. Heterophylly has been considered by all authors an important feature that distinguishes for



FIG. 1. *Polygonum aviculare* subsp. *buxiforme*; the lectotype. (*J.K. Small s.n.* NY 323754.)

TABLE 1. Comparison between the subspecies of *Polygonum aviculare*. Mature early season plants with leaves, flowers and achenes are necessary for accurate determinations. Measurements of leaves and ochreas were made at the middle of main stem. Description of perianth refers to fruiting perianth, which was measured from the joint with the pedicel. Description of achene uses the terminology of Wolf and McNeill (1986).

	Polygonum aviculare subspecies					
Characters	**ssp. aviculare** = *P. monspeliense* Pers. = *P. heterophyllum* Lindm.	**ssp. boreale** (Lange) Karlsson = *P. boreale* Lange	**spp. buxiforme** (Small) Costea and Tardif	**ssp. rurivagum** (Jord. ex Boreau) Berher = *P. rurivagum* Jord. ex Boreau = *P. aviculare* var. *angustissimum* Meisn.	**ssp. neglectum** (Besser) Arcang. = *P. neglectum* Besser = *P. aviculare* ssp. *rectum* Chrtek	**ssp. depressum** (Meissn.) Arcang. = *P. aviculare* ssp. *microspermum* (Jord. ex Boreau) Berher = *P. arenastrum* Boreau = *P. aequale* Lindm. = *P. calcatum* Lindm. = *P. microspermum* Jord. ex Boreau. = *P. montereyense* Brenckle
STEMS; Number Position of main stems	1–3 ascending–erect; rarely procumbent	1–6 procumbent-ascending	1–3 or numerous procumbent-ascending	numerous procumbent-ascending	numerous procumbent-ascending; rarely erect	numerous procumbent, rarely ascending
OCREAE; Size Appearance	(5–)6–10(–12) mm free part soon dissolved into fibers	3.5–6.5(–8) mm free part disintegrating with almost no fibrous remnants	3.5 6.5(–8) mm free part silvery, relatively persistent, with inconspicuous veins, after disintegrating with or without fibrous remnants	(6.5–)8–12.5 mm free part with strong and brown veins, persistent after disintegrating	(3.6–)4–8.1mm free part with inconspicuous veins, after disintegrating with almost no fibrous remnants	a) 3–5.5 or b) 8–12 mm **a)** free part with inconspicuous veins after disentegrating leaving almost no fibrous remnants

						b) free part persistent, silvery, overlapping toward the stem and branch apices
LEAVES; Shape of lamina	elliptic to oblanceolate	spathulate to obovate	elliptic to obovate; narrow elliptic to lanceolate or oblanceolate	very narrow-elliptic to linear-lanceolate	narrow-elliptic to oblanceolate	elliptic to narrow-elliptic or oblanceolate
Shape of lamina apex	acute or obtuse	obtuse to rounded	obtuse to acute	acute	acute	obtuse or acute
Length	(10–)20–55 (–65) mm	(10–)15–45(–50) mm	6–30(45) mm	(10–)15–30 mm	(7.5–)12–35(–45) mm	7.5 -30 mm
Width	6–20(–26) mm	5–20(–26) mm	3–6(–13) mm	2.5–5(–9) mm	2–6(–10) mm	2–8(–13) mm
Ratio length : width	2–4.5(–5.5)	2–4(–5)	2.5–5.6(–10)	(4–)5–13.5(–15)	(3.5–)4.3–8.5(–10)	(2–)2.8 5.5(–9)
Ratio length of middle stem leaves and adjacent branch leaves	(1.1–)1.5–4	(1.1)1.3 3	1·2.5(–3.3)	1.2–2.4(–3.2)	1–2.5(–3.3)	1–2.5(3)
Color	pure green	pure green	gray-green	pure green	pure green	pure green or gray-green
Petiole	1–6.5 mm	1–7.5 mm	0.3–2(–3.5) mm	0.3 2 mm	0.5–3(–5) mm	0.5–3.5(–4.5)
CYMES; Nr. of flowers	(2–)4–8	(2–)4–8	2–6(–8)	1–3	1 4(–6)	(1–)2–5(–8)
Distribution of cymes on the stems	congested at the top stems and branches	± uniformly	± uniformly, rarely congested at the top stems and branches	± uniformly; rarely congested at the top stems and branches	± uniformly	± uniformly; rarely congested at the top stems and branches
PERIANTH; Size	(2.3–)2.6–4.8(–5) mm	(3–)3.3–5.5 mm	(2–)2.3–3.4(–3.6) mm	(2)2.3–3.2 mm	(2–)2.2–3.4(3.6) mm	(2–)2.2–3.5(–4) mm
Ratio length : width	1.8–2.8	1.6–2.8	0.9–1.3 (–1.5)	1.6–2.6	1.6–2.6	1.5–2.9

Table 1. continued

	Polygonum aviculare subspecies					
The perianth tube represents (%) of perianth length	(10–)20–36%	(15–)25–36(–40)%	20–36(–40)%	20 36(40)%	25–45(–50)%	40–58%
Outer 3 tepals	laterally overlap ping; oblong, cucullate, green with broad pink, purple, red or white borders; veins dendriticly branched, strongly thickened	aterally overlap-ping; obovate, flat or outcurved, green with very broad white (sometimes pink) margins; veins dendriticly brancned, moder-ately to strongly tickened	laterally overlap-ping; cucullate, oblong; the base with a poach like protrusion; green with narrow, usually white borders; veins dendriticly branched, moderately to strongly thickened	not overlapping, oblong; + cucullate; green with usually pink borders; veins dendriticly branched, strongly tickened	not overlapping to slightly so; oblong, ± cucullate to flat; green with usually pink borders; veins dendriticly branched; moder-ately to strongly thickened	not overlapping; oblong; obscurely cucullate to flat; green with white margins which may be reddish-brown in the innermost part; veins unbranched, not thickened
ACHENE; Size	(2.2–)2.4–3.7 mm	(2.4–)2.7–4 mm	(1.8–)2–2.8 (–3) mm	(1.6–)2–2.6 (3) mm	(1.6–)1.8–2.8(–3) mm	(1.6–)1.8–2.8 mm
Morpnology	enclosed in the perianth or only the tip v sib e; dark-brown, with 3 subequal, concave, coarsely striate-papillose faces; apex straight	enclosed in the perianth dark-brown, with 3 subequal, concave, coarsely striate papillose faces; apex straight	usually enclosed; dark-brown to light-brown, with 3 subequal, concave to flat faces; coarsely striate-papillose to obscurely striate papillose; apex straight, sometimes slightly beaked	usually exerted (achene edges are visible); dark-brown; with 3 subequal, concave to flat and coarsely striate-papillose faces; sometimes one face is narrower; apex straight	usually exerted (achene edges are visible); dark-brown; often with one face narrower; faces concave to flat; coarsely straite papillose faces, (rarely only roughened); apex straight or a little bent toward tne narrow face	usually exerted; dark or light-brown; with one face narrower or sometimes biconvex; faces flat, almost smooth to coursely striate-papillose; apex straight or a little bent toward the narrow face

Chromosome numbers	2n = 40, 60	2n = 40	2n=60	2n = 60	2n = 40, 60	2n = 40, 60
Intergrades with:	ssp. *neglectum*, ssp. *buxiforme*, ssp. *boreale*	ssp. *aviculare* ssp. *buxiforme?*	ssp. *aviculare*, ssp. *boreale?*	ssp. *neglectum*, ssp. *depressum*	ssp. *rurivagum*, ssp. *depressum*	ssp. *rurivagum*, ssp. *neglectum*, ssp. *buxiforme*?
Origin	Eurasia	Northwestern Europe, Greenland	North America	Europe	Eurasia	Europe
Distribution	frequent across all of North America	Greenland, rare in Labrador	frequent across all of North America	rare in North America (Costea & Tardif, in ed.)	across most of North America, but less frequent than ssp. *depressum*	common across all of North America
Ecology	weed in ruderal places and cultivated fields; more sensitive to drought and trampling tnan ssp. *depressum*	sea-shores in open sand, drift banks and rocky shores shores	weed in ruderal habitats or sometimes agrestal; nondrifting sands, borders of marshes and dunes	dry and sunny habitats; mostly ruderal growing in pavement cracks and gravel	growing in all types of ruderal and agrestal habitats	agrestal and ruderal in heavily trampled habitats; sometimes in turf or grazed grasslands

example subsp. *aviculare* (= *P. aviculare* s. str.) from the homophyllous taxa: subsp. *depressum* (= *P. arenastrum*) and subsp. *neglectum* (= *P. neglectum*). It was stated that heterophyllous plants have cauline leaves which are more than three times as long as the branch leaves, while homophyllous plants have stem and branch leaves of about the same size (e.g. Wolf & McNeill 1986). The ratio between the lengths of middle stem and branch leaves (Table 1) shows that using the above definitions, some plants of subsp. *aviculare* may be considered homophyllous, while some of the subsp. *depressum* and subsp. *neglectum* may be characterized as heterophyllous. Heterophylly is not always a clear cut character and it can be efficiently used by taking into account the mentioned ratios (Table 1). In other words, keeping in mind that some taxa are "more heterophyllous" than others. Another potential source of error is the morphology of the tepals. Cucullate tepals are said to be distinctive for North American taxa such as subsp. *buxiforme*. In contrast, the non-native taxa (e.g. subsp. *aviculare*) are said to possess flat tepals (Mitchell & Dean 1978). This is not true as subsp. *aviculare*, subsp. *neglectum* and often subsp. *depressum* may also exhibit cucullate tepals in fruit (Table 1).

2. Polygonum hudsonianum (Wolf & McNeill) Hinds

Wolf and McNeill (1986) described this taxon as a subspecies of *P. caurianum*. Later, Hinds (1995) observed that subsp. *hudsonianum* was clearly differentiated from *P. caurianum* and he raised the former to specific rank. However, the author noted that the "separation of *P. fowleri* and *P. hudsonianum* is [...] more difficult" (Hinds 1995). Indeed, intermediate plants may occur between the two taxa, making their identification problematic at times. Therefore, taking into account that *P. caurianum* is distinct from both (see below), we propose the classification of *P. hudsonianum* as a subspecies of *P. fowleri*:

Polygonum fowleri Robinson subsp. **hudsonianum** (Wolf & McNeill) Costea & Tardif, comb. nov. BASIONYM: *Polygonum caurianum* Robinson subsp. *hudsonianum* Wolf & McNeill, Rhodora 88:469. 1986. *Polygonum hudsonianum* (Wolf & McNeill) Hinds, Novon 5:165. 1995. TYPE: CANADA. QUÉBEC: Fort George, 30 Aug 1950, *E. Lepage 12863* (HOLOTYPE: DAO 539717!; ISOTYPE: QFA!).

3. Polygonum humifusum Merk ex Koch

Hultén (1968) observed that *P. caurianum* Robinson might be "closely related or identical" to *P. humifusum* Merck ex Koch from Siberia and Kamtschatka. The BONAP list (1998) explicitly considered the latter name as a nomenclatural synonym of the former. However, it must be noted that *P. humifusum* is the correct binomial because it has priority. This species has a unique feature: the lower leaves are often opposite, and Tzvelev (1979) even separated it in a distinct subsection - *Humifusa*. The closest North American species is *P. fowleri*, which may rarely (especially subsp. *hudsonianum*) have a few leaves that are opposite. For differences, see Hinds (1995). The comparison of Russian and North

American specimens of *P. humifusum* revealed morphological differences, which together with the disjunct geographical distribution allow the recognition of two subspecies:

Polygonum humifusum Merk ex Koch, Linnaea 22:205. 1849.

a. subsp. **humifusum**
Stems and leaves green. Perianth 1.5–2.0 mm, with ± erect tepals, green with white margins, only in some flowers with pink margins. Achene 2.1–2.7 mm, ± rostrate, the apex exserted 0.9–1.3 mm. 2n = 20. (Tzvelev 1979). Siberia and Kamtschatka.

b. subsp. **caurianum** (Robinson) Costea & Tardif, comb. et stat. nov. BASIONYM: *Polygonum caurianum* Robinson Proc. Bost. Soc. Nat. Hist. 31:264.1904. TYPE: U.S.A. ALASKA: Nushagak, 59° N 158° W, Aug 1882, *C.L. McKay s.n.* (HOLOTYPE: GH 32603!).

Stems and leaves reddish or purplish tinged (if leaves are green, at least the margins are reddish or purplish). Perianth 1.5–2.3(–3) mm, with ± outcurved tepals, green or purple with the margins pink to purple. Achene 1.4–1.6(–2.2) mm, not or obscurely beaked, with the apex exserted 0.1–0.5 mm. Chromosome number unknown. NW Alaska, Yukon and NW Territories.

4. Polygonum prolificum (Small) B.L. Robinson

Polygonum prolificum was originally described by Small (1894) as a variety of *P. ramosissimum*, and later it was raised to species rank by Robinson (1902). Mitchell and Dean (1978) mentioned that the specimens of the two taxa "show too much intergradation to be separated with satisfaction" and we confirm their findings. The subspecific rank is proposed for *P. prolificum*.

Polygonum ramossisimum Michx. subsp. **prolificum** (Small) Costea & Tardif, comb. et stat. nov. BASIONYM: *Polygonum ramossisimum* Michx var. *prolificum* Small, Bull. Torrey Bot. Club 21:171. 1894. *Polygonum prolificum* (Small) Robinson, Rhodora 4:68. 1902. TYPE: U.S.A. NEBRASKA: Exeter, *J.H. Wibbe s.n.* (HOLOTYPE: NY 323808!).

Polygonum prolificum var. *autumnale* Brenckle, Phytologia 2:404. 1948
Polygonum prolificum var. *profusum* Brenckle, Phytologia 2:404. 1948.

For differences between the two taxa see Mitchell and Dean (1978) and Wolf and McNeill (1986). Subsp. *prolificum* is less variable and less common than subsp. *ramossisimum*, growing mostly in wet, saline places, which are scattered across all of North America.

5. Polygonum texense M.C. Johnston

Recently, *P. texense* has been considered a synonym of *P. striatulum* (BONAP 1998; Hatch et al. 2002). Although the morphology of the flowers and fruits is very similar, the two perennial taxa are distinct on the basis of their leaf morphology and their different phenology and ecology. The varietal rank is proposed here for *P. texense*:

Polygonum striatulum Robinson var. **texense** (M.C. Johnston) Costea & Tardif, comb. et stat. nov. BASIONYM: *Polygonum texense* M.C. Johnston, Southw. Naturalist 14:257. 1969. TYPE: U.S.A. TEXAS, *J. Scudday* s.n. (HOLOTYPE: LL.; ISOTYPE: LL!)

For morphological differences between var. *striatulum* and var. *texense* see Correll and Johnston (1970). Plants of var. *striatulum* grow in eastern and southeastern Texas, while plants of var. *texense* occur in central-western Texas and southeastern New Mexico.

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BOOK NOTICE

CHARLES B. HEISER. 2003. **Weeds in My Garden: Observations on Some Misunderstood Plants.** (ISBN 0-88192-562-4, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $22.95, 260 pp., 29 color photos, 30 line drawings, 5 1/2" × 8".

From the dust jacket: "Weeds, by their nature, get around. This book treats about 140 weeds, and more than half of these may be found throughout most of North America. Many were originally native to eastern North America, and others first came from Eurasia. The author chooses weeds that have found their way into "his garden," the Botany Experimental Field at Indiana University where he has grown plants for more than half a century."

Reading through Heiser's wonderful book on weeds brought back pleasant childhood memories. For I know weeds from a different kind of "garden," my dad's cotton field in southwestern Oklahoma. Dad was a cotton farmer and a good one at that. Being born during cotton harvest time (in the fall) in the middle of the 20th century, mother tells me I made my first trip to a cotton field at the early age of a few days to one week. It was there in those cotton fields back home where I had my first and up close encounters with plants, albeit cotton plants. I didn't do any collecting (not that I remember) except for lots of sleep in the shade of the cotton wagon. I occasionally took a ride down the cotton rows on the top of mother's cotton sack. By the time cotton is ready to harvest most of the weeds have been pretty much eliminated from the "garden" by either a cultivator or by a hoe. As I got older I discovered weeds through "chopping cotton" with a hoe, and it didn't take long to learn that "chopping cotton," meant chopping weeds. Dad taught me—early in life—my first lessons in identifying plants (weeds). Positive "identification" of cotton field "weeds" was of the utmost importance; dad made sure of that, for "chopping cotton" was all about weed identification ... that is, all of the "unwanted" plants growing sometimes intimately with those beautiful cotton plants. What is a weed? For me it was any plant but cotton?—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

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TAXODIOMERIA (TAXODIACEAE), AN INTERGENERIC HYBRID BETWEEN *TAXODIUM* AND *CRYPTOMERIA* FROM SHANGHAI, PEOPLE'S REPUBLIC OF CHINA

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ABSTRACT

We describe in this paper the hybrid genus ×*Taxodiomeria* Z.J. Ye, J.J. Zhang et S.H. Pan, gen. nov. (*Taxodium* Rich. × *Cryptomeria* D. Don) and the hybrid species ×*T. peizhongii* Z.J. Ye, J.J. Zhang et S.H. Pan, sp. nov. (*Taxodium mucronatum* Ten. × *Cryptomeria fortunei* Hooibrenk ex Otto et Dietr.) (Taxodiaceae). The hybrid originated in Nanjing in 1963 and was introduced into Shanghai in 1975; it has been propagated vegetatively since then. These hybrids, about 2000 in all, were hardly known but are now big trees and highly valued for their fine shape, faster growth rate, and adaptation to urban environments compared to *Taxodium* and *Metasequoia*. Morphologically, the hybrid species strongly resembles *Taxodium mucronatum*, differing slightly in a few vegetative characteristics.

ABSTRACT (CHINESE)

本文对杂交属 *Taxodiomeria* Z.J. Ye, J.J. Zhang et S.H. Pan, gen. nov. (*Taxodium* Rich. × *Cryptomeria* D. Don) 和杂交种 *T. peizhongii* Z.J. Ye, J.J. Zhang et S.H. Pan, sp. nov. (*Taxodium mucronatum* Ten. × *Cryptomeria fortunei* Hooibrenk ex Otto et Dietr.) (Taxodiaceae) 作了描述。该杂种 1963 年在南京杂交成功，1975 年引入上海，并进行无性繁殖，现有大树约 2000 株。这些杂种过去鲜为人知，但如今因其树形美观，生长速度快于落羽杉属（*Taxodium*）和水杉属（*Metasequoia*）树种且更能适应城市环境，而受到高度重视。该杂种在形态上与墨西哥落羽杉（*Taxodium mucronatum*）很相似，但在一些营养体特征上与后者有差异。

A new intergeneric hybrid *Taxodiomeria peizhongii* Z.J. Ye, J.J. Zhang et S.H. Pan of Taxodiaceae, described below, arose from a cross between *Taxodium mucronatum* Ten. (♀) and *Cryptomeria fortunei* Hooibrenk ex Otto et Dietr. (♂). It is said that a number of individuals of *Taxodium mucronatum* were introduced into China around 1925, but now only two were found living. One was on the campus of Dongnan University of Nanjing, the maternal plant of the hybrid species. *Cryptomeria fortunei*, a native of southeastern China, is widely

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cultivated in the area south of the Yangtze River, but the paternal tree of the hybrids has not been found. The hybrid cross was made in Nanjing in 1963 by the late Prof. Ye Pei-Zhong, a prominent botanist specializing in the cross-breeding of trees. Finally he was able to produce three cones and a number of hybrid seedlings, but only five of the 12 F_1 seedlings survived (Anonymous 1979; Miao et al. 1982). About 6000 cuttings were prepared in successive years up until 1972. Some of these were introduced to Shanghai, Hangzhou, Wuhan, and other cities in China. It seems that the hybrid saplings had not shown any valuable silvicultural characteristics superior to the related species of *Taxodium*, *Metasequoia*, and *Cryptomeria*. Therefore, they did not excite much interest among dendrologists in Nanjing. This is probably why there are only a limited number of hybrid trees growing there today.

Some 260 hybrid saplings were introduced into Shanghai for the first time in 1975 under the supervision of professors Cheng Xu-Ke and Jin Guo-Pei. From 1975 to 1983, thousands of young plants were propagated vegetatively from these saplings in the tree nurseries of Songjiang and Yangjing while Ye Zheng-Ji, the fifth author of this paper, was in charge of the work of cultivation and propagation of the hybrids in Songjiang. However, for lack of sufficient knowledge as to the merits and potentialities of the hybrid trees and also for some other reasons, the number of trees gradually decreased; these were hardly known to the public until the end of the 1990s.

The discovery of the hybrids was the result of a survey for tree resources of Shanghai carried out by Ye Zheng-Ji and his colleagues from 1998 to 2001. They have found that the 20–30 year-old F_1 hybrids—about 2000 in all—have proven to be very successful in Shanghai compared to *Taxodium distichum* (L.) Rich., *T. ascendens* Brongn., *Metasequoia glyptostroboides* Hu et Cheng, and *Cryptomeria fortunei* Hooibrenk ex Otto et Dietr. These hybrids are semi-evergreen, grow fast, hold up to strong winds, and thrive not only in ordinary garden soil but also in wetlands and saline sea-shores with a soil pH ranging from 6.5 to 8.6. The trees can grow in saline soil with 0.4% salt. A small plantation of the hybrids was seen growing well in a lake in Songjiang. These data are congruent with the statements that hybrids sometimes respond better than their parents (Stebbins 1969) and that they may show new characters not present in either parent (Knobloch 1972). The stand of hybrids in Chuansha Tree Nursery, the largest one in Shanghai—with about 1500 individuals covering an area of about 1.8 ha.—was designated "The Protected Forest of Germplasm Resources of Shanghai" by the municipal authorities in 2001. These trees are 30–40 cm. in diameter at breast-height, and the largest is about 62.5 cm. in diameter. The hybrid species is useful for landscape planting as well as for large-scale windbreaks in the riverine and coastal regions of Shanghai and neighboring provinces. Since the climatic and edaphic conditions (the more or less alkaline soil and the high groundwater level) in Shanghai are not very favorable for growing many kinds

of trees, these new hybrids are bound to play an important role in the rapid development of gardening and urban forestry in the city.

×**Taxodiomeria peizhongii** Z.J. Ye, J.J. Zhang et S.H. Pan, gen. et sp. nov. (**Figs. 12, 13**). *Taxodium mucronatum* Ten. (♀) and *Cryptomeria fortunei* Hooibrenk ex Otto et Dietr. (♂). TYPE: CHINA. SHANGHAI: Jinshan, Jinshan General Petrochemical Works, cultivated tree more than 20 m high, diameter breast-height ca. 50 cm, bearing juvenile male strobili, strips of bark transversely fissured, 25 Sep 2001, *S.H. Pan 01563A* (HOLOTYPE: PE; ISOTYPES: NAS, SHM).

Haec species hybrida speciei materno *Taxodio mucronato* Ten. valde similis, a quo praecipue differt planta ut in specie paterno sine geniculis et anteridibus etiam crescenti in terra humida, trunco integro nec dilatato ad basin et plerumque in summo altitudinem 5–8 metrorum duobus pluribusve ramulis primariis diviso raro recto et simplice, corticis schedis longis angustisque saepe transversaliter fissuratis tecto, et surculis multis in ramulis primariis vel etiam in trunco instructa. Strobili a nobis non visi praeter plantis singulis ex Jinshanensi in autumnum amentis masc. immaturis 6–12 cm longis secus ramulos hornotinos dispositis paniculam pendulam formantibus instructis. Strobili masc. immaturi unusquisque 6 staminibus praediti.

In cultura in solo usitato horti et in terris humidis et etiam in littoribus salsis.

PARATYPE: **CHINA. Shanghai:** Songjiang, Zuibaichi Park, cultivated, 21 Sep 2001, *S.H. Pan 01540* (SHM); Pudong, Yangjing Nursery, cultivated, in flooded ground, 12 Aug 2001, *S.H. Pan 01275A* (FUS); Shanghai, Pudong, Chuansha Tree Nursery, in a stand along the coast, 1 Sep 2001, *S.H. Pan 01400* (SHM).

The specific epithet *peizhongii* honors Prof. Ye Pei-Zhong of the former Nanjing Forestry College, who made this hybrid by crossing *Taxodium mucronatum* (♀) and *Cryptomeria fortunei* (♂).

This hybrid species resembles the maternal species *Taxodium mucronatum* Ten. in the spirally arranged, drooping, annual leafy shoots that drop shortly before the new shoots leaf out in spring and in having closely arranged, distichous, short (<1cm long) leaves (Fig. 11). The phenomenon of matro-clinal inheritance of the hybrids has recently been confirmed by RAPD analysis (Chen et al. 2002). This report has shown that the genetic distance of the hybrids from *T. mucronatum* (0.210–0.246) is much shorter than that of the hybrids from *Cryptomeria fortunei*, their paternal species (0.757–0.764). Morphologically, the hybrid differs from the maternal species chiefly in a few significant characters. It does not have butswells (knee-like growths) and buttresses (as in the paternal species), the trunk is usually divided at a height of 5–8 m into two or more primary branches and, consequently, the crown has forms such as conical, cylindric, ellipsoid, and pyriform, etc., all of them being more or less round-topped. Rarely is the trunk straight and undivided. The narrow, long strips of bark are usually transversely fissured. There are many shoots on the primary branches or even on the trunk.

Buttresses and butswells are characteristic of the genus *Taxodium* (Harrison 1966; Hart & Price 1990), though butswells are only occasionally seen in *T. mucronatum* (Hart & Price 1990; Martinez 1950), and their presence depends to a great extent on the environmental conditions in which the plants grow (Kurz



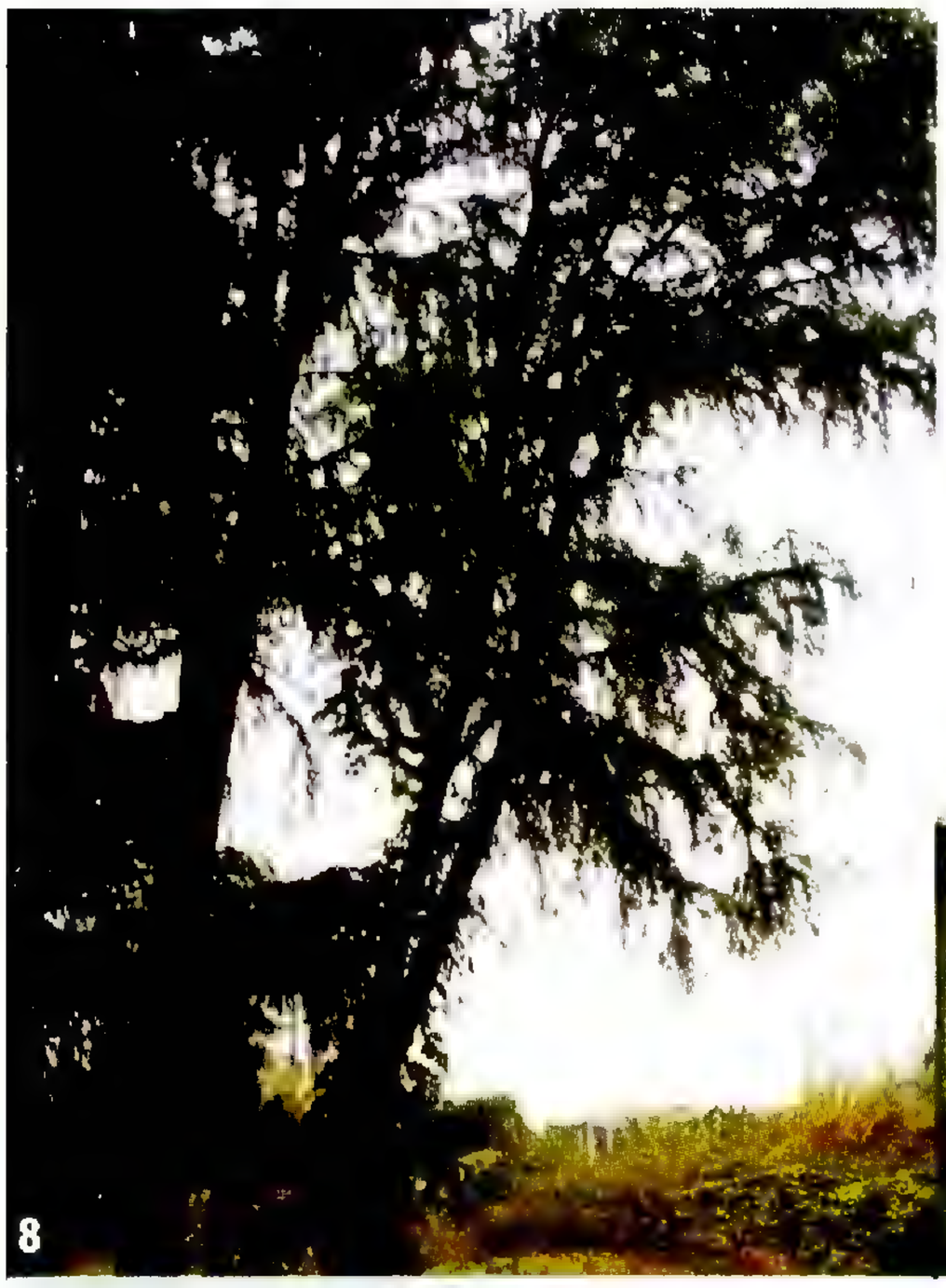
Fig. 1. Base of the trunk of ×*Taxodiomeria peizhongii* growing in Chuansha Tree Nursery, Shanghai, showing lack of buttresses.

Fig. 2. Base of the trunk of *Taxodium mucronatum* Ten. (maternal plant of the hybrid) cultivated in the campus of Dongnan University, Nanjing, showing the buttresses.

Fig. 3. Base of the trunk of *Taxodium mucronatum* Ten. growing in Giant Park of Washington, D.C. The photo was taken in September 2002 when the fifth author of this paper was visiting the United States.



Fig. 4. Close shot of the bark of ×*Taxodiomeria peizhongii* growing in Chuansha Tree Nursery, Shanghai, showing the transversely fissured strips.
Fig. 5. Close shot of the bark of ×*Taxodiomeria peizhongii* growing in Chuansha Tree Nursery, Shanghai, showing the transversely fissured strips.
Fig. 6. Close shot of the lower part of ×*Taxodiomeria peizhongii* growing in Chuansha Tree Nursery, Shanghai, showing the divided trunk.
Fig. 7. Individuals of ×*Taxodiomeria peizhongii* growing in Yangjing Tree Nursery, Shanghai, showing the divided trunks.


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Fig. 8. Two individuals of ×*Taxodiomeria peizhongii* growing in Yangjing Tree Nursery, Shanghai, showing the divided trunks.

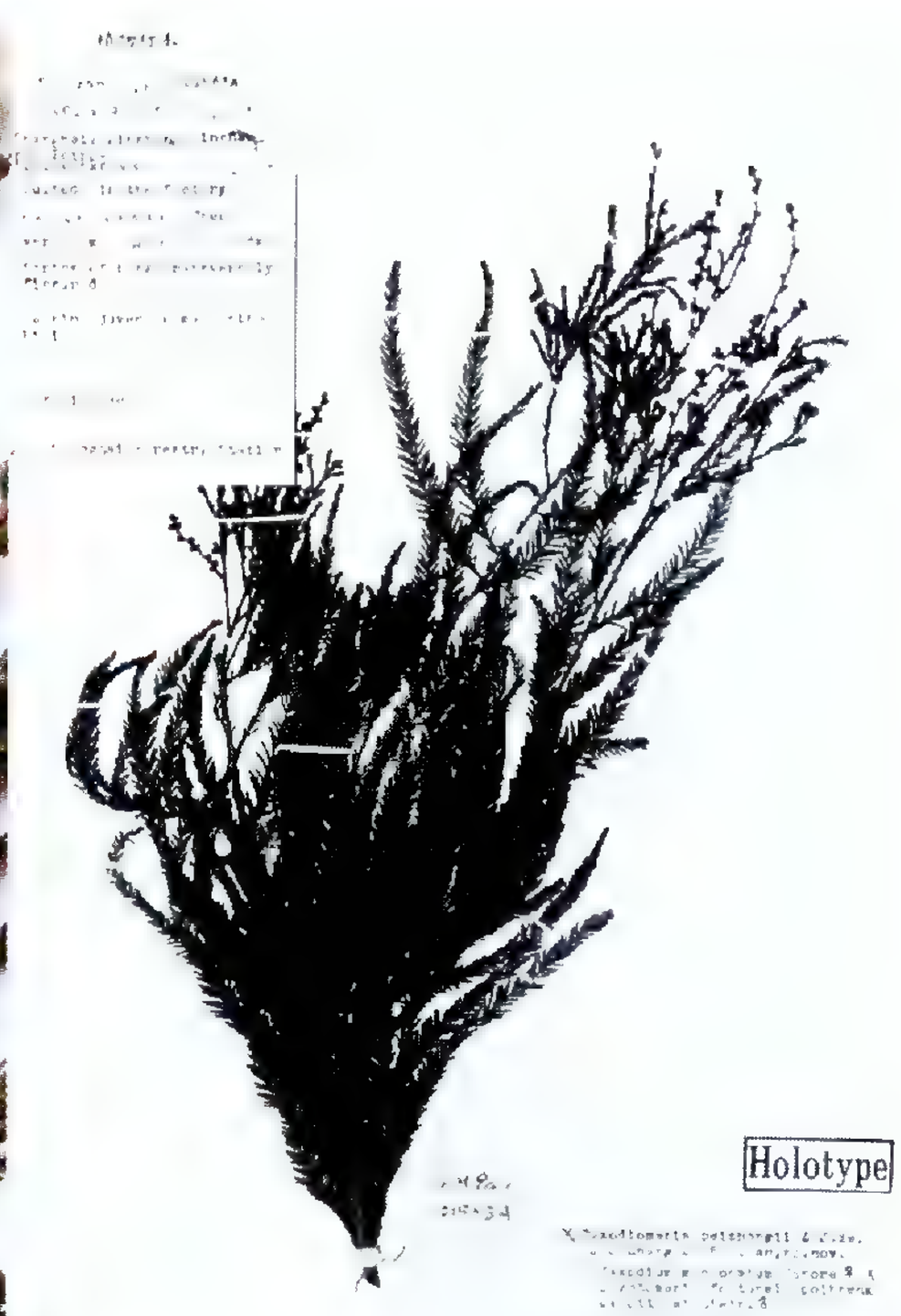
Fig. 9. ×*Taxodiomeria peizhongii* in Chuansha Tree Nursery, Shanghai.

Fig. 10. ×*Taxodiomeria peizhongii* in a residential quarter near Yangjing Tree Nursery, Shanghai.

Fig. 11. Close shot of a leafy branch and branchlets of ×*Taxodiomeria peizhongii* growing in Yangjing Tree Nursery, Shanghai.



12



13

FIG. 12. Close shot of branchlets with male strobili of ×*Taxodiomeria peizhongii* taken from the type specimen tree cultivated in Jinshan, Shanghai.
FIG. 13. Holotype of ×*Taxodiomeria peizhongii*.

& Demaree 1934). In the present hybrid species, however, the trunk is integral and buttresses and butswells have never been seen even in plants growing either in wetlands or in seasonally flooded lowlands. Thus, it can be seen that there is a difference between the hybrid species and *Taxodium mucronatum* concerning the presence or absence of butswells or buttresses.

It seems that different tree forms have something to do with age in *Taxodium*, from columnar, to more conical, and to flat topped (J. Li, pers. comm. 2001). The hybrid trees are of conical habit when young but develop a wide and often flattened crown when old (Harrison 1966; Hart & Price 1990). But no matter how great the variation of the tree forms may be, the trees maintain their straight trunks and do not form double multiple leaders as do most of our hybrid trees.

Although the hybrids generally have no strobili, at least now, some individuals cultivated in Jinshan have been found to bear male catkins 6–12 cm long assembled into pendulous panicles on the present year's shoots in autumn [2002]. These immature male strobili possess six microsporophylls each and are expected to open in spring 2003.

KEY TO VEGETATIVE DIFFERENCES BETWEEN ×*TAXODIOMERIA PEIZHONGII* AND *TAXODIUM MUCRONATUM*

1. Base (trunks) of adult trees in either wetlands or in saline soil without buttresses (Fig. 1), butswells (knee-like growths) absent; long narrow strips of bark usually transversely fissured (Figs. 4, 5); tree usually divided at a height of 5–8 m into 2 or more primary branches (Figs. 6, 7, 8); crown with many different forms, conical, cylindric, ellipsoid, pyriform, etc.—but with more or less a rounded top (Figs. 9, 10) _____ **×Taxodiomeria peizhongii**

1. Base (trunks) of adult trees always with a swollen and often buttressed bases (Figs. 2, 3), butswells (knee-like growths) frequently present in flooded areas; long narrow strips of bark never transversely fissured; tree conical in habit when young, but developing a wide and often flattened crown when old _____ **Taxodium mucronatum**

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A NEW SPECIES OF *DIOSCOREA* (DIOSCOREACEAE) FROM THE ANDES OF VENEZUELA

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ABSTRACT

A new species of *Dioscorea*, *D. lisae* Dorr & Stergios, is described and illustrated. Relationships, distinguishing characters, and sex distribution are discussed. Information also is provided on the ecology and geographical distribution of this new species.

KEY WORDS: Dioscoreaceae, *Dioscorea*, Venezuela, Andes

RESUMEN

Se describe y se ilustra una nueva especie de *Dioscorea*, *D. lisae* Dorr & Stergios. Se discuten las relaciones, caracteres particulares y la distribución del sexo. Además, se presenta información de la ecología y distribución geográfica de esta especie nueva.

PALABRAS CLAVES: Dioscoreaceae, *Dioscorea*, Venezuela, Andes

Four species of *Dioscorea* L. (Dioscoreaceae) have been collected in Guaramacal National Park, which protects an area of ca. 200 km^2 of montane forest, cloud forest, and páramo near the northern end of the Cordillera de Mérida in Portuguesa and Trujillo states, Venezuela (Dorr et al. 2000). Two of the species, *D. lehmannii* Uline and *D. meridensis* Kunth, are well-circumscribed although infrequently collected and with wide ranges in the Andes, extending south to Ecuador and Peru. When we published a catalogue of the vascular plants of Guaramacal, we had not yet identified two of the four species, and we listed them as *Dioscorea* sp. A and *Dioscorea* sp. B (Dorr et al. 2000). The latter appears to be *D. coriacea* Humb. & Bonpl. ex Willd., a variable species with a number of synonyms and an extensive range in the Andes (Colombia and Venezuela to Bolivia). The former, however, cannot be associated with any known species and is described here as new.

Dioscorea lisae Dorr & Stergios, sp. nov. (**Figs. 1–2**). TYPE: VENEZUELA. TRUJILLO: Mpio. Boconó, Parque Nacional Guaramacal, road from Boconó to Guaramacal, SE of Boconó, N slope of mountain, 09°13'N, 070°12'W, 2000 m, 13 Jul 1995 (♂, ♀, fls), *Dorr & Barnett 8057* (HOLOTYPE: PORT; ISOTYPES: MEXU, US).

Species *Dioscorea coriacea* affinis, a qua imprimis differt tereticaulibus, pedicellis longioribus et foliis 5–7-nervis.

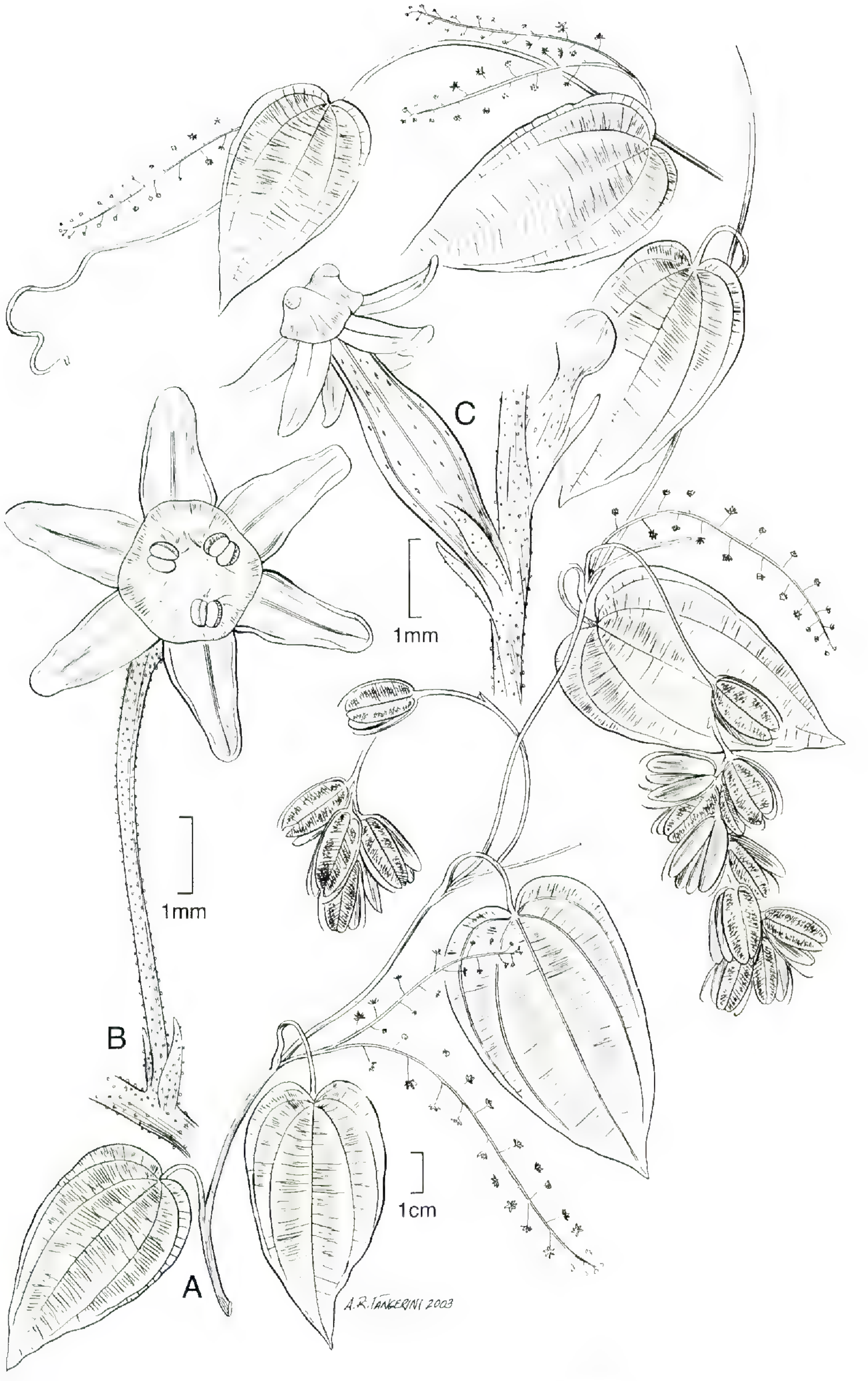


FIG. 1. *Dioscorea lisae* Dorr & Stergios. A. Habit (of a plant with mixed inflorescences, either male inflorescences or male inflorescences arising from the axils of infructescences). B. Staminate flower. C. Pistillate flower. (A, *Dorr et al. 8921*, US; B, *Dorr & Barnett 8057*, PORT; C, *Dorr & Barnett 8057*, MEXU).

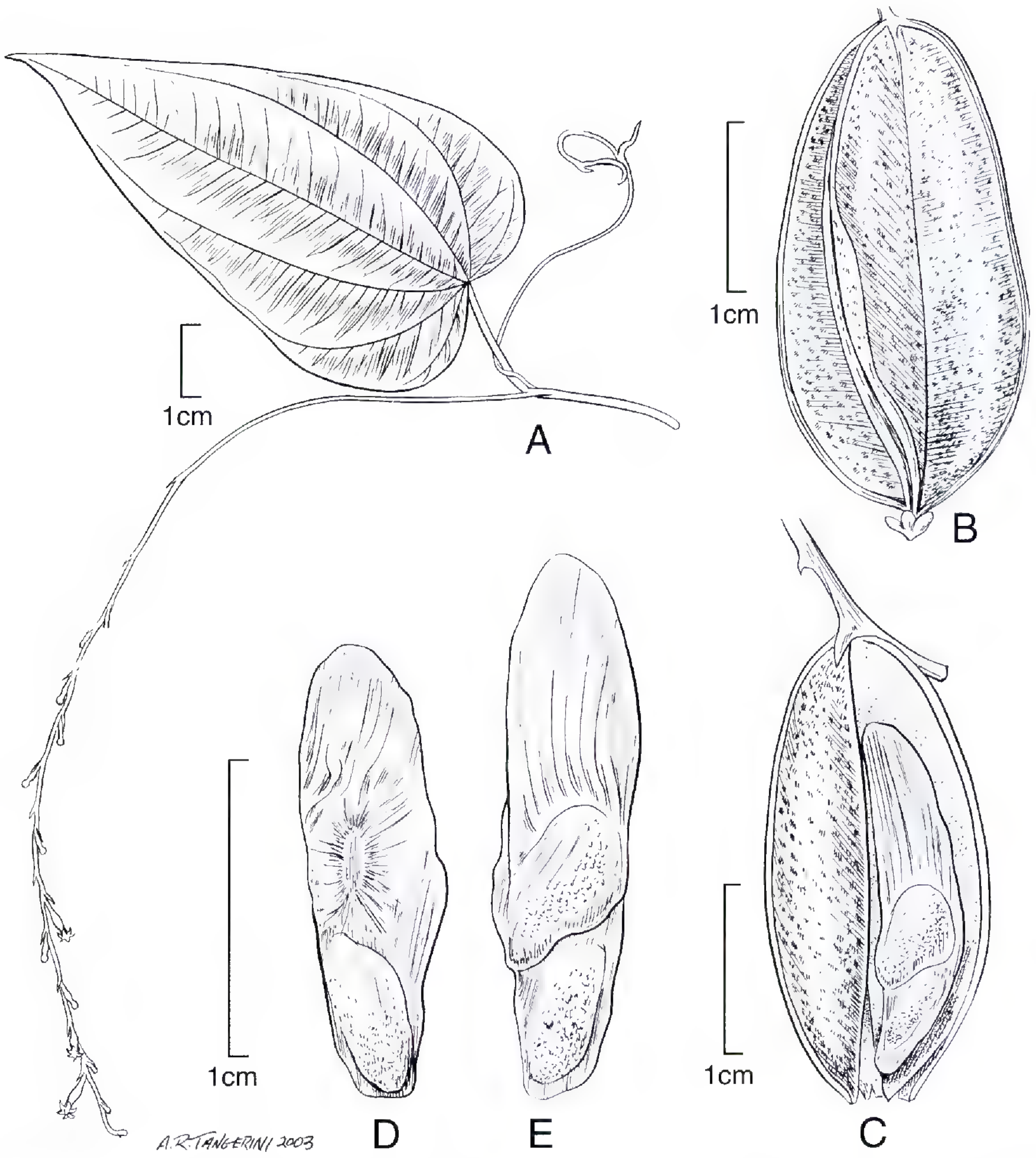


FIG. 2. *Dioscorea lisae* Dorr & Stergios. A. Female inflorescence. B. Capsule. C. Capsule, part of fruit wall removed to show orientation of seeds and seed wings. D, E. Seeds. (A, *Dorr et al. 8057*, US; B–E, *Stergios et al. 17034*, US).

Herbaceous twining vines; dioecious (or monoecious, with staminate inflorescences found on pistillate plants in fruit). Stems delicate, terete, twisting to the right (dextrorse), glabrous. Leaves alternate, entire. Leaf blades ovate-lanceolate, 7–11 × 3.2–5 cm, 5–7-nerved, the base cordate to truncate, the apex acuminate to long-acuminate, glabrous, membranous; petioles 1.5–3.5 cm long, glabrous, faintly glandular-dotted below. Staminate inflorescences paniculate, pendent, 8-13 cm long, with 1–4 racemose branches, flowers solitary, the rachis minutely-papillate, delicate; each flower subtended by a pair of unequal, acicular bracteoles, ca. 1–1.25 mm long; pedicels 5–8 mm long, minutely-papillate to

smooth. Staminate flowers greenish-red (*Licata & Cuello 217*) to purple (*van der Werff & Ortega 6066*), rotate at anthesis, the tepals equal, distinct, 1.25–1.5 × 0.75 mm, lanceolate, glabrous; stamens 3, borne on a flattened, annular disc, filaments very short, ca. 0.25 mm tall, thickened, anther cells ovoid, free (or connivent), introrsely dehiscent; staminodia absent. Pistillate inflorescences spicate, pendent, to 14 cm long, solitary; each flower subtended by a pair of unequal, acicular bracteoles ca. 1.5–1.75 mm long. Pistillate flowers with tepals equal, distinct, ca. 1–1.25 × 0.5 mm, lanceolate, glabrous; styles 3, fused at the base and free towards the apical stigmatic surfaces; staminodia absent. Capsules 2–3 × 1.2–1.4 cm, elliptic, the apex and base rounded, flattened, green (drying light brown) with dark, elliptic maculations, glabrous; seeds 2 per locule, ca. 0.5 × 0.5 cm, irregularly lenticular to ovate-lenticular, compressed, winged dorsally, the wing to 1 cm long, membranous.

PARATYPES. **VENEZUELA. Trujillo:** Mpio. Boconó, Parque Nacional Guaramacal, vertiente norte, subiendo por la Laguna Negra, 2620 m, Jun 2002 (♂ fls, fr), *Cuello 2433* (PORT); Parque Nacional Guaramacal, road from Boconó to Guaramacal, SE of Boconó and just above park headquarters, N slope of mountain, 09° 13'N, 070° 12'W, 5 Jul 1995 (♂ fls), *Dorr et al. 7981* (NY, PORT, US); Parque Nacional Guaramacal, road from Boconó to Guaramacal, SE of Boconó, N slope of mountain (09° 13'N, 070° 12'W), 29 Oct 1998 (♂, ♀, fls), *Dorr et al. 8381* (PORT, US); Parque Nacional Guaramacal, trail from El Cafenol (E of Mosquey) to Fila Los Recostaderos, 1790–2200 m, 12 Jun 2001 (♂, ♀, fls), *Dorr et al. 8896* (PORT, US), Ibid (♂ fls, fr), *Dorr et al. 8921* (PORT, US); Parque Nacional Guaramacal, en la vertiente norte, 09° 25'7"N, 070° 13'34"W, 1950 m, 4 Jun 1995 (♂ fls), *Licata & Cuello 217* (PORT-unicate); Parque Nacional Guaramacal, sector vertiente sur, carretera al caserío Guaramacal, 2000–2750 m, Feb 1997 (fr), *Stergios et al. 17034* (PORT, US); entre Boconó y Guaramacal, 2100–2300 m, 4 Sep 1966 (♂ fls), *Steyermark & Rabe 97309* (US, VEN); near Boconó, Páramo de Guaramacal, 09° 14'N, 070° 11'W, 2600–3100 m, 22 Nov 1984 (♂ fls), *van der Werff & Ortega 6066* (MO, PORT).

Distribution and ecology.—*Dioscorea lisae* is presently known only from the Ramal de Guaramacal in Trujillo state, Venezuela. This ridge is a 40 km long offshoot of the more extensive Cordillera de Mérida, which extends 325 km from Táchira to Lara. All but one of the collections we examined are from the north slope (mostly Qda. Segovia) of the Cerro de Guaramacal; the sole exception is a collection from the south slope (Qda. Jirajara) of the same mountain. *Dioscorea lisae* has been collected in montane and upper-montane forest; 1790–2750 (–3100) m. Flowering June, July, September, and November; fruiting February.

The US sheet of *Steyermark & Rabe 97309* is mislabeled with a locality in Táchira and the date 27 August 1966. Bono (1996: 526) also reported this collection (as *Dioscorea coriacea*) from Táchira, which suggests other duplicates may be mislabeled. Steyermark's field notes are unambiguous about the fact that he and Marvin Rabe collected a *Dioscorea* in Guaramacal on 4 September 1966 and that the collection was numbered 97309. Since all of the data on the labels used by Steyermark are printed save for the collection number and determination, which are typed, it is easy to imagine a typist grabbing one or more labels from the wrong stack when preparing the distribution of duplicate sheets.

Etymology.—The epithet honors Lisa Ceryle Barnett, botanist, science administrator, and wife of LJD. She has participated in many collecting trips to Guaramacal as well as numerous other expeditions by foot, mule, horse, or jeep to remote forests and páramos in the Venezuelan Andes.

DISCUSSION

Following the classification of Knuth (1924), *Dioscorea lisae* belongs in subg. *Helmia* (Knuth) Benth.; the ovules are attached near the distal (stylar) end of the ovary and the wing is developed unilaterally toward the proximal end (i.e., toward the base of the capsule). Several characters, including the presence in male flowers of a large glandular disc (not always readily apparent) and racemose male inflorescence branches with solitary flowers that have 3 anthers and lack staminodia, suggest a placement in sect. *Cycladenium* Uline of Knuth's (1924) scheme. In Huber's (1998) classification, *D. lisae* keys to sect. *Trigonobasis* Uline of Mexico and Central America, which he also associates with sect. *Cycladenium*.

Dioscorea lisae differs from other species in sect. *Cycladenium* in that its male flowers have very long pedicels, which greatly exceed the bracteoles in length, and its female flowers produce relatively large capsules, which have rounded (versus acute) apices and bases. As noted above, at least one of the specimens (*Steyermark & Rabe 97309*) we refer to *D. lisae* was misidentified earlier as *D. coriacea*, but *D. lisae* differs from that species in a number of morphological characters summarized in Table 1.

Dioscorea lisae apparently is not strictly dioecious. One of our collections (*Dorr et al. 8921*, US) has fruit and male inflorescences and it would appear that the sexes are separated temporally. In this case the male inflorescences evidently arise well after the female inflorescences have produced flowers and set fruit. Condon and Gilbert (1988, 1990) discuss what might be an analogous situation in the Cucurbitaceae. The genera *Gurania* (Schltdl.) Cogn. and *Psiguria* Arn., both neotropical vines that were long thought to be dioecious, are actually monoecious and only temporally dioecious. They documented that these genera have size-related and intra-seasonal sex changes. They also discovered strongly male-biased sex ratios. Our limited sample size (ten collections) hints at a male-biased sex ratio in *D. lisae*; nine collections have male flowers and six have female flowers and/or fruit. Nonetheless, the exact nature of sex expression in this species and factors controlling the same are not at all clear and will not be resolved with herbarium specimens alone.

While *Dioscorea* is almost universally considered to be dioecious, there are a number of other reports, usually dismissed, that this is not true of all species. Burkill (1960: 327) summarized the prevailing view by stating categorically "to date we do not have a single proved case of the two sexes being fertile on the one individual: what we have is records of imperfect male organs and imperfect

TABLE 1. Selected morphological characters distinguishing *Dioscorea lisae* and *D. coriacea*.

	D. lisae	D. coriacea
stems	terete	angular
leaves	5–7 nerved	7–9-nerved
pedicel length	5–8 mm	2–4 mm
capsule size	2–3 × 1.2–1.4 cm	1–2 × 0.5–0.8(–1.2) cm
capsule apex	rounded	acute

female organs intruded into what may be fertile individuals of the other sex." Al-Shehbaz and Schubert (1989: 67) referred to the reports of such deviation as "abnormally-monoecious"; Huber (1998: 220) cited a "a few reports of monoecy, most of them referring to American species ..."; and Caddick et al. (2002: 109) wrote that plants of *Dioscorea* are "dioecious but vestigial male/female parts [are] usually present." Xifreda (1982a, b; 1983; 1984), studying Argentinian species of *Dioscorea*, described *D. furcata* Griseb., *D. hieronymi* Uline ex R. Knuth, *D. megalantha* Griseb., *D. stenopetala* Hauman (all sect. *Cycladenium*), *D. demourae* Uline ex R. Knuth, *D. haumanii* Xifreda (both sect. *Monadelpha* Uline), and *D. pilcomayensis* Haumen (sect. *Centrostemon* Griseb.) as monoecious. She also observed infraspecific variation in male flowers of several species, notably *D. megalantha*; in some collections the glandular disc is not readily apparent or is incompletely developed, while in others it is fully accrescent. She attributed this anomaly to collections being made at different stages in floral development. Hammel (2000), relying upon his field knowledge of populations of *D. lepida* C.V. Morton (sect. *Trigonobasis*), recently reported that this Central American species is monoecious and that it flowers precociously with staminate flowers, then produces pistillate flowers toward the apex of an inflorescence and even some hermaphroditic flowers. Plants of *D. lepida* observed in a later flowering or fruiting stage consequently show little or no evidence of the staminate inflorescences. Given the evidence presented here and by Hammel (2000), it seems clear that careful field observations need to be coupled with herbarium, laboratory, and greenhouse studies to clarify what could be a wide range of different floral sex strategies in *Dioscorea*.

ACKNOWLEDGMENTS

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Lauren Raz (NY), and an anonymous reviewer for critical comments. The illustrations were prepared by Alice Tangerini.

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Key Words: Alpine plants; mountain plants (West U.S., Canada, western); wild flowers; identification, cultivation.

FESTUCA DENTIFLORA (POACEAE: LOLIINAE: SECT. *GLABRICARPAE*), A NEW SPECIES FROM PERU AND TAXONOMIC STATUS OF *F. PRESLIANA*

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ABSTRACT

A new species, *Festuca dentiflora* E.B. Alexeev ex Stančík & P.M. Peterson from the Andes of Peru, is described and illustrated. The new species is a member of *Festuca* subg. *Subulatae* (Tzvelev) E.B. Alexeev sect. *Glabricarpae* E.B. Alexeev and is apparently closely related to *Festuca caldasii* (Kunth) Kunth from Ecuador and Colombia. A key to the species of *Festuca* sect. *Glabricarpae* is included. In addition, the taxonomic status and geographical origin of *F. presliana* is discussed.

RESUMEN

Se describe e ilustra una especie nueva de *Festuca* de los Andes de Perú: *F. dentiflora* E.B. Alexeev ex Stančík & P.M. Peterson. La nueva especie pertenece a *Festuca* subg. *Subulatae* (Tzvelev) E.B. Alexeev sect. *Glabricarpae* E.B. Alexeev, se considera estrechamente relacionada aparentemente con la especie *F. caldasii* (Kunth) Kunth de Ecuador y Colombia. Se presenta también una clave para la determinación de las especies de *Festuca* sect. *Glabricarpae*. Además, se discute el estatus taxonómico y origen geográfico de *F. presliana*.

The Russian botanist, E.B. Alexeev, recognized several specimens with unique features while studying South American material of *Festuca* in the United States National Herbarium (US). Alexeev marked many specimens as new species with herbarium names, however, some of these were never published. The status of some of his proposed new species is problematic since, in many cases, only type material exists, and species concepts in *Festuca* are highly variable. In this paper, we describe a new grass species from Peru based upon a specimen that was selected and given an herbarium name by E.B. Alexeev.

The new species, *Festuca dentiflora* E.B. Alexeev ex Stančík & P.M. Peterson, appears to belong in *Festuca* subg. *Subulatae* (Tzvelev) E.B. Alexeev, sect. *Glabricarpae* E.B. Alexeev, in the subtribe Loliinae, tribe Poeae, and subfamily Pooideae (Soreng et al. 2000). Section *Glabricarpae* is one of four sections (sect. *Elmera* E.B. Alexeev, sect. *Glabricarpae*, sect. *Longiglumes* S.L. Lu, and sect. *Subulatae* E.B. Alexeev) in subg. *Subulatae* (Tzvelev) E.B. Alexeev. Section *Glabricarpae* differs from sect. *Elmera* by having flat leaf blades without prominent ribs, and differs from most species of sect. *Subulatae* by having ovate spike-

lets that are significantly longer (> 11 mm long), scabrous lemmas (usually glabrous in sect. *Subulatae*), significantly longer anthers (3.5–5 mm long), and glabrous ovary apices. While the distribution of species in sect. *Elmera* is restricted to the southwestern North America, sect. *Longiglumes* is known only from China and sect. *Subulateae* is sub-cosmopolitan in its distribution (Lu 1992; Stančík & Peterson 2002). By inclusion of the new species, sect. *Glabriformae* consists of five species, two (*F. breviglumis* Swallen, *F. chiriquensis* Swallen) restricted to Mesoamerica and three (*F. caldasii*, *F. dentiflora*, *F. woodii* Stančík) found in northern South America (Alexeev 1980, 1982, 1986; Stančík 2001, 2003). Based on morphological comparisons, *F. dentiflora* appears closely related to *F. caldasii* (Kunth) Kunth.

Festuca dentiflora E.B. Alexeev ex Stančík & P.M. Peterson, sp. nov. (**Fig. 1**). TYPE: PERU. DEPARTAMENTO HUÁNUCO. Provincia Baños: U.S. Exploring Expedition of Capt. *Wilkes* 5 (HOLOTYPE: US-1006459!).

Haec species a *Festuca caldasii* (Kunth) Kunth spiculis 11–12 (non 15–17) mm long., glumis majoribus (inferioribus 4.5–6 non 3.5–4 mm long., superioribus 7–8 non 4.5–6.5 mm long.), lemmate minoribus (8.5–10 non 10–14 mm long.), aristis majoribus (6–8 non 1–3 mm long.) differt.

Perennial, loosely tufted. Culms about 100 cm tall, erect, glabrous, with 2–4 nodes in basal half. Sheaths membranous, glabrous, margins free, innovations extravaginal; auricles absent. Ligules 3.5–4 mm long, membranous, acute, lacerate. Blades (only a fragment seen) 3–4 mm wide, flat, green, glabrous. Panicles about 20 cm long, 10–15 cm wide, ovate; branches erect or sometimes spreading, in pairs at each node, scabrous. Spikelets 11–12 mm long, ovate; florets 4–5 (perfect); rachillas 1.2–1.8 mm long, densely pilose. Glumes lanceolate, brownish-green with membranous margins; lower glume 4.5–6 mm long, 1-veined; upper glume 7–8 mm long, 3-veined. Lowermost lemmas 8.5–10 mm long, lanceolate, coriaceous-membranous, green, hairy, 5-veined; apex bi-dentate with an awn 6–8 mm long; callus glabrous. Paleas almost as long as lemma, membranous, two-keeled, scabrous; apex two-dentate, hairy. Lodicules oblong-lanceolate. Stamens 3; anthers 4.5–5 mm long. Ovary apex glabrous. Caryopses not observed.

Transversal section of leaf blade.—Leaf section with many vascular bundles, without ribs; bulliform cells not observed; sclerenchyma under both abaxial and adaxial epidermis discontinuous, without hairs.

Distribution.—Known only from the type locality in Peru.

Etymology.—The specific epithet, as marked on the specimen by E.B. Alexeev, probably refers to the bi-dentate lemma and palea.

DISCUSSION

Section *Glabricarpae* is quite homogenous and all five species (*F. breviglumis*, *F. caldasii*, *F. chiriquensis*, *F. dentiflora*, *F. woodii*) are morphologically very simi-

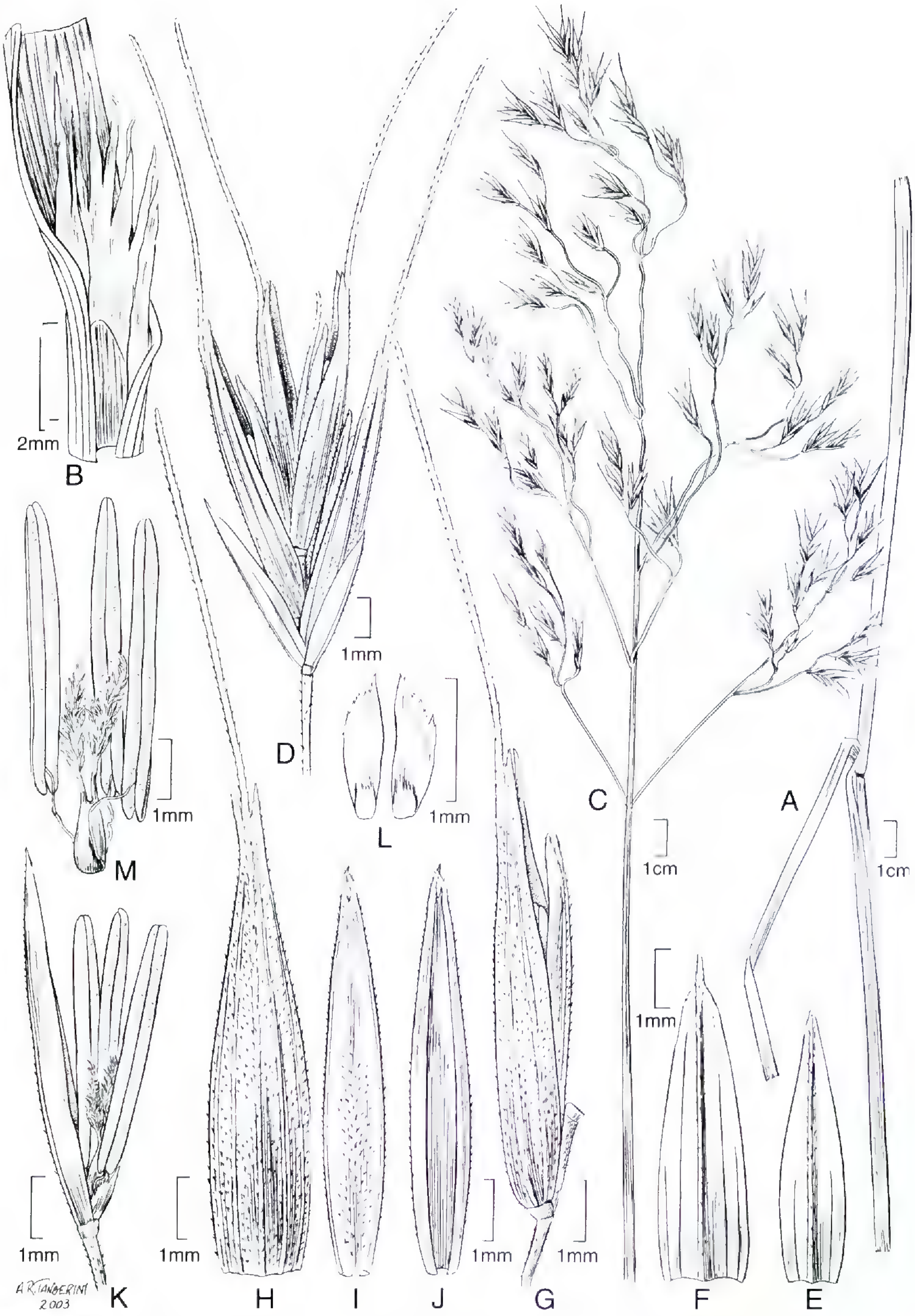


FIG. 1. *Festuca dentiflora* (*Wilkes 5*). A. Culm (portion of). B. Sheath, ligule, and portion of the blade. C. Inflorescence. D. Spikelet. E. Floret. F. Lower glume, dorsal view. G. Upper glume, dorsal view. H. Lemma, dorsal view. I. Palea, dorsal view. J. Palea, ventral view. K. Palea, lodicules, stamens, and pistil. L. Lodicules (2). M. Stamens and pistil.

lar (Table 1). In comparison with other members of this section, *F. dentiflora* and *F. woodii* have shorter spikelets (11–14 mm long verses 15–20 mm long), *F. dentiflora* and *F. caldasii* have longer ligules (2.5–4 mm long verses 0.5–1.1 mm long), and *F. dentiflora* and *F. breviglumis* have longer awns (6.5–15 mm long verses 0.5–4 mm long).

KEY TO THE SPECIES OF *FESTUCA* SECT. *GLABRICARPAE* IN SOUTH AMERICA

1. Spikelets 10–14 mm long, lemmas 10–16 mm long.
   2. Lower glumes 7–8.5 mm long, upper glumes 9–12 mm long _____ **Festuca chiriquensis**
   2. Lower glumes 3.5–5(-6.5) mm long, upper glumes 4.5–8.5 mm long.
      3. Ligules 0.5–0.8 mm long, lemma awn 7–15 mm long _____ **Festuca breviglumis**
      3. Ligules 0.5–3 mm long, lemma awn 1–3 mm long _____ **Festuca caldasii**
1. Spikelets 15–20 mm long, lemmas 8.5–9.5 mm long.
   4. Ligules 0.5 mm long, lemma awn 0.5–1 mm long, anthers 3.5–3.7 mm long _____ **Festuca woodii**
   4. Ligules 3.5–4.5 mm long, lemma awn 0.5–1 mm long, anthers 3.5 3.7 mm long _____ **Festuca dentiflora**

Alexeev (1986) also included *F. presliana* Hitchc. in sect. *Glabricarpae*, but the status of this species is not clear (see Table 1). The type specimen of *F. presliana* differs from the other members of sect. *Glabricarpae* by having 3-veined, membranous, and papillate or short scabrous (not long scabrous) lemmas. Since *F. presliana* has lanceolate lemmas with long awns and short anthers it may be more correctly placed in *Festuca* subg. *Subulatae* sect. *Subulatae*. The type specimen of *F. presliana* was originally described as *Bromus depauperatus* J. Presl [Reliq. Haenk. 1(4-5): 263.1830] from a specimen (*Haenke s.n.*) collected by the Czech botanist, Thaddaeus Peregrinus Xaverius Haenke, as a member of Malaspina Expedition (1789-1793). Haenke collected about 15,000 plant specimens on this expedition. However, a large part of this material was destroyed during transportation (Stern 1973) and only a small part of the collection reached the European continent and was finally acquired by Kaspar von Sternberg in 1821 for the National Museum in Prague. Under the leadership of K.B. Presl, processing and determination of this material and results were published in Reliquiae Haenkeanae (Presl 1825-30, 1831-35). New grass species were described by J.S. Presl. A major part of this collection has recently been deposited in the National Museum Herbarium in Prague (PR), and duplicate sets can be found in the Herbarium of Charles University in Prague (PRC) and in other herbaria (K, MO, US, W).

A taxonomic revision of *Festuca* in Colombia has recently been completed by the senior author (Stančík 2003), and the status of *F. presliana* is still unclear. While Presl described the type specimen as *Bromus depauperatus* and mentioned "sinu Nootka" (=Vancouver Island) as the type locality, Hitchcock (1927) in his treatment of South American grasses, transferred this taxon to the genus *Festuca* and created a new name *F. presliana* Hitchcock to replacing the

TABLE 1. Morphological comparison of the South American species of *Festuca* sect. *Glabricarpae* and *F. presliana*.

Taxon	***F. caldasii***	***F. woodi*** (in press)	***F. breviglumis***	***F. chiriquensis***	***F. dentiflora***	***F. venezuelana*** (in press)	***F. presliana***
Herbarium	PRC	COL	US	Taken from description in Davidse (1994)	US	US	PR
Collector	*S. Laegaard*	*J.R.I. Wood*	*R. McVaugh*		*C. Wilkes*	*E.P. Killip*	*T.P.X. Haenke*
Number	*20405*	*5254*	*24827*		*5*	*19719*	*s.n.*
Geographical distribution	Colombia, Ecuador	Colombia	Mesoamérica (Mexico-Panama)	Mesoamérica (Mexico-Panama)	Peru	Colombia, Venezuela	not clear (see discussion)
Culm height (cm)	70–150	80	55–130	80–130	100	120	70
Sheath base	sligntly fibrous	fibrous	slightly fibrous	slightly fibrous	?	fibrous	fibrous
Ligule size (mm)	2.5–3	0.5	0.5–0.8	0.5–1.1	3.5 4	2.5–3	0.5–0.8
Ligule apex	acute	truncate	?	?	acute	truncate	truncate
Blade length (cm)	20–35	50–60	19–35	15–50	?	25	27
Blade width (mm)	3–9	2.5–5	5–8	4–-7	3–3.5	6-9	5.5–6.5
Panicle size, length × width, (cm)	13–17 × 5–8	15 × 20	15 × 17–22	10–15 × 15–30	20 × 10–15	20 × 17	17 × 10
Spikelet length (mm)	15–17	12–14	15–20	15–20	11–12	12	10–12
Number of florets	5–7	4–5	4–5	?	4–5	5	2 (not complete)
Lower glume length (mm)	3.5–4(5)	4.5 -5.5	3–5(6.5)	7–8.5	4.5	5–6	4–5
Upper glume length (mm)	4.5–6.5	6–7.5	5–8.5	9–12	7–8	6–7	5.5–6.5
Lemma length (mm)	10–14	8.5–9	13–15.5	14–16	8.5–9.5	8–9	9.5–10
Lemma apex	two-dentate	two-dentate	two-dentate	two-dentate	two-dentate	two dentate	two-dentate
Number of lemma veins	5	5	5	5	5	5	3
Awn length (mm)	1–3	0.5–1	7–15	1–4	6.5–8	6–9	8
Anther length (mm)	3.5–4.5	3.5–3.7	2.5–5.2	3–4.5	4.5	1.7–2	2.5
Ovary apex	glabrous	glabrous	glabrous	glabrous	glabrous	not seen	glabrous

blocking name, *F. depauperata* Bertol (Fl. Ital.1: 620.1834). Hitchcock also discussed the geographical origin of this specimen comparing Haenke´s collection with the specimen of Wilkes Expedition (type specimen described here as *F. dentiflora*). Hitchcock concluded that the type locality published by Presl was in error because neither the specimens nor the description corresponds with any North-American species of *Festuca*. Hitchcock, suspected the "true identity" of the *F. presliana* type to be from Baños, Peru. This opinion, at first, appeared highly probable because a large portion Haenke´s specimens come from Huánuco region of central Peru (Fig. 1b in Kühnel 1960). In the Flora of Peru, Macbride (1936) also accepted Hitchcock's opinion.

Alexeev (1986) opened a new discussion on the geographical origin Haenke's specimen and compared the northern South American collections of *Festuca* with a specimen of Killip [*Killip & Smith 19719* (US)] from the Cordillera Oriental of Colombia. Alexeev concluded that Hitchcock´s opinion of the Peruvian origin was erroneous and that *Festuca presliana* is a species endemic to Colombia.

There are no doubts about the placement of Haenke's specimen in the genus *Festuca* since it has an open sheath, glabrous ovary, and a caryopsis that does not adhere to the lemma. A comparison of the type specimens of *Haenke s.n.*(*F. presliana*) and *Wilkes 5* (*F. dentiflora*) with the Killip & Smith specimen, suggests that Peruvian and Colombian origin of *F. presliana* are in error. The specimens do not represent the same species (see Table 1 for comparison). The Peruvian specimen (*Wilkes 5*) is described here as a new species (*F. dentiflora*), and the Killip & Smith specimen represents a new species (*F. venezuelana*) from Venezuela (Stančík 2003). In addition to the specimen comparisons above, a reconstruction of Haenke´s itinerary in South America indicates (Fig. 1a & b in Kühnel 1960) that he never reached the Cordillera Oriental of Colombia. A reexamination of Haenke´s specimen using Hitchcock and Chase (1951), Soderstrom and Beaman (1968), Stewart and Hebda (2000), Serna and López-Ferrari (2000), Beetle (1991), Macbride (1936), Pinto-Escobar (1981), and Davidse (1994) also excluded the possibility that it is of American origin.

The most important morphological feature distinguishing *F. presliana* is the 3-veined lemma, that is commonly 5–15-veined in *Bromus* and usually 5-veined in *Festuca*. Interestingly, there are only five known species of *Festuca* with 3-veined lemmas. In addition to *F. presliana*, Clayton and Renvoize (1986) mentioned the following four species with 3-veined lemmas: *F. africana* (Hack.) Clayton and *F. engleri* Pilg. From Africa, *F. altissima* Boiss. from Eurasia, and *F. asthenica* Hook. f. from Asia. All of these species come from the Old World. The two African species are placed in the wide-spread, *Festuca* Subg. *Subulatae* (Stančík in prep.), whereas the Eurasian/Asian species are alligned with *Festuca* Subg. *Drymanthele* (Aleexev 1977). The occurrence of taxa with 3-veined lem-

mas in the Old World is remarkable. However, use of this observation as support for the extra-American origin of this Haenke type is probably insufficient. Other cases of confusion in the location of Haenke´s collections are known, for example, Alston (1934), Lamson-Scribner (1899), Merrill (1906), and Veldkamp et al. (1991). Frequently there is confusion with reports of South American species as occurring in Luzon (Philippines) and vice versa. Revision of *Bromus* and *Festuca* in the Philippines is needed and could clear up some of this confusion.

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THE GENUS *PACKERA* (ASTERACEAE: SENECIONEAE) IN COLORADO, U.S.A.

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ABSTRACT

Fourteen species of *Packera* are known to occur in Colorado. Recently published floras for the state have treated these species variously as *Packera*, *Senecio* and *Ligularia*. While preparing a treatment of this genus for the Flora of North America Project, the author discovered some confusion among the local botanists who rely on those floras for identifications of this difficult group. This paper presents descriptions for each of the species that occur in the state, comments on how to differentiate them in the field, and identification keys.

RESUMEN

Se conocen catorce especies de *Packera* en Colorado. Las floras del estado publicadas recientemente han tratado estas especies de modo diferente como *Packera*, *Senecio* y *Ligularia*. Mientras preparaba un tratamiento de este género para la Flora de Norte América, el autor encontró confusión entre los botánicos locales que usan estas floras para las identificaciones de este grupo difícil. Este artículo presenta descripciones de las especies que viven en el estado, comentarios sobre como diferenciarlas en el campo, y claves de identificación.

INTRODUCTION

What Distinguishes a *Packera* from a *Senecio*?

Traditionally, species now included in *Packera* were relegated to the genus *Senecio*, a large genus of over 3,000 species. In the early 1800s DeCandolle (1838) provided a worldwide treatment of *Senecio*. He recognized 16 informal groups, based largely on geographic distribution. Greenman (1915, 1916, 1917, 1918) and Rydberg (1900) had varying definitions and numbers of informal "species groups." Through the 1960s into the 1980s Barkley (1962, 1968a, 1968b, 1978, 1980) published several papers on three of these informal groups, the *Aurei*, the *Lobati* and the *Tomentosi*, which he collectively referred to as the "Aureoid Senecios."

Within *Senecio* s.l., most of the taxa have a base chromosome number of x=10 or derivatives thereof. However, Löve and Löve (1976) pointed out that there was a group of anomalous species whose chromosomal base number was either x=22 or x=23 and had a suite of unique morphological characters. Furthermore those taxa corresponded to three New World groups informally recognized by Barkley: the *Aurei*, the *Lobati*, and the *Tomentosi*. They proposed that these species be placed in a new genus, *Packera*, based primarily on gross morphology and chromosome number.

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The recognition of *Packera* was not immediately accepted and still is not recognized by some workers. However, support for recognizing *Packera* has grown over the past 25 years. Molecular, palynological, and cytological data, while doing little to help clarify relationships between species in this group, have all lent support for recognizing the genus *Packera*. These types of data are acquired by laboratory work, but how does a botanist in the field decide if he/she is looking at a *Packera* or a *Senecio*? Table 1 provides a comparison of characters that are useful for field or herbarium identifications. Often a combination of these features will be needed to make a determination.

MATERIALS AND METHODS

While preparing a treatment of the genus *Packera* for the *Flora of North America* project, I borrowed specimens from many regional herbaria, and visited several others to obtain both accurate distribution records, and a good understanding of the morphological variation that is characteristic of these species. I have also made four collecting trips through the central part of Colorado, where the diversity of *Packera* is the highest. During the course of that work it became apparent that there was confusion among local botanists concerning which characters provide for accurate identification, and about which species belong in the genus *Packera*, and which are still treated as *Senecio* s.l.

I have examined over 1100 Colorado specimens from the following herbaria: Adams State College (ALAM); Botanical Research Institute of Texas (BRIT); Brigham Young University (BRY); Canadian Museum of Nature (CAN); Colorado College (COCO); Colorado State University (CS); Kansas State University (KSC): Miami University (MU); Missouri Botanical Garden (MO); Montana State University (MONT); New York Botanical Garden (NY); North Dakota State University (NDA); Northeast Louisiana University (NLU); Oregon State University (OSC); Rancho Santa Ana Botanic Garden (RSA); Rocky Mountain Herbarium (RM); University of Alaska Museum (ALA); University of British Columbia (UBC); University of California (UC); University of Colorado (COLO); University of Kansas (KANU); University of New Mexico (UNM); University of Southern Colorado (PUSC); University of Washington (WTU); and Vanderbilt University (VDB).

The goal of this paper is to provide descriptions, keys, common synonyms, and a discussion of the most useful morphological characters to assist botanists in their efforts to accurately identify species in this genus. Dot maps providing distribution information for each species are presented in Figures 1, 2 and 3.

Generic characters of Colorado *Packera* species

All taxa of *Packera* are exclusively herbaceous, and most are perennials. Three of the Colorado species, *P. multilobata*, *P. plattensis*, and *P. neomexicana* can also

TABLE 1. Comparison of characters useful for field or herbarium identifications of *Packera* and *Senecio*.

Packera	Senecio	Informal Groups of Barkley within *Senecio*
Leaves progressively reduced distally	Leaves concentrated distally, or equally distributed along the stem	*Suffruticosi*
Heads erect on peduncles	Heads nodding	*Amplectentes*
Phyllaries occasionally with reddish tips. Rarely black-tipped, and if so, middle cauline leaves NOT clasping	Phyllaries with prominent black tips, AND middle cauline leaves clasping	*Amplectentes*
Caudices taprooted or rhizomatous, with branching fibrous lateral roots	Caudices button-like or lateral rhizomes, with fibrous roots unbranched and fleshy	*Lugentes, Boreali, Integerrimi*

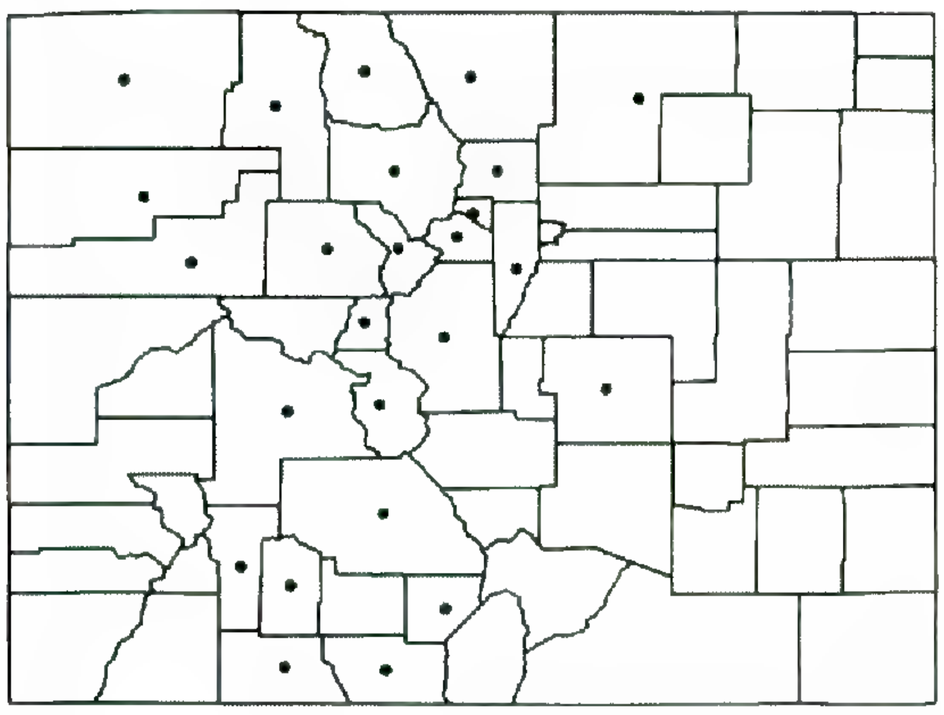
be biennials, and *P. neomexicana* may occasionally be a winter annual. Stems of all Packeras consistently grow from either a single or a cluster of basal rosettes.

The perennating structure is a woody caudex or a shortened rhizome. A caudex is the persistent base of an herbaceous stem that normally arises from a taproot. In some species the caudex is short, thin, and weak, while in others it can become elongated, branching, stout, and woody. Species that inhabit steep rocky slopes have creeping rhizomatous caudices. Taxa growing in wet meadows or other mesic environments frequently have abundant fibrous roots, which may almost completely disguise the presence of the caudex.

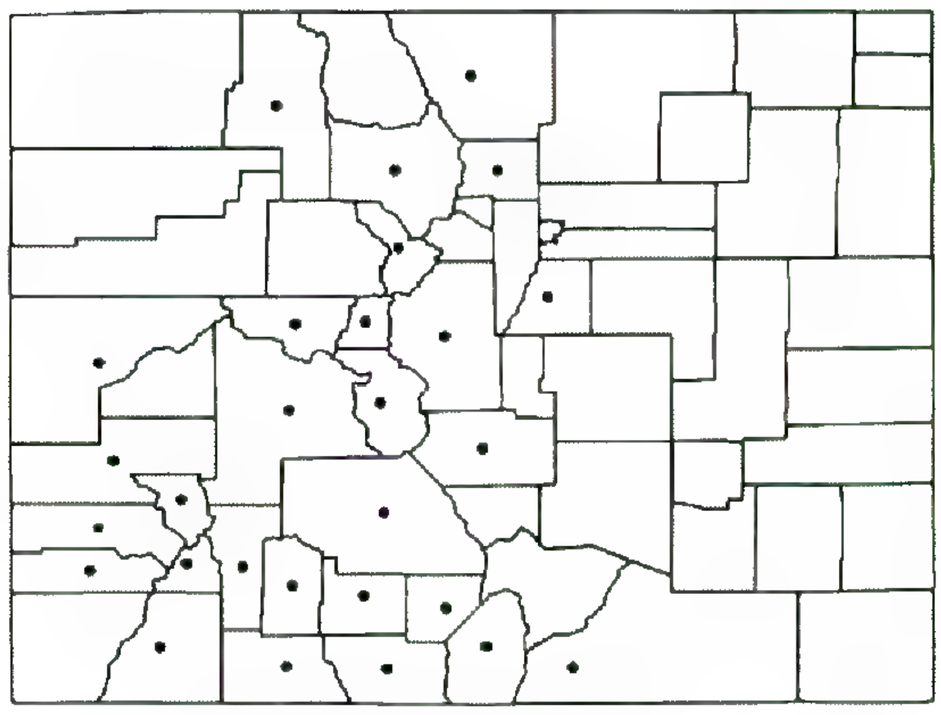
Stems are normally single from the caudex or taproot. However, because in many species the caudex is more or less branching, it may appear that there are several stems clustered together, but usually no more than four or five. Some species may have stems that display anthocyanic (reddish) pigments. *P. multilobata*, growing in open sagebrush habitats, and *P. porteri*, growing on talus slopes both exhibit this characteristic.

There is considerable variation in the amount of pubescence along the stems. In Colorado, *P. cana, P. fendleri*, and *P. werneriifolia* are nearly always densely tomentose. Other species vary widely in the amount and persistence of tomentum. Almost all Packeras have at least some pubescence restricted to the base of the stem and to the axils of the leaves when young. Although the presence or absence and location of pubescence is commonly used in keys and descriptions, it should only be used in conjunction with other characters when identifying specimens.

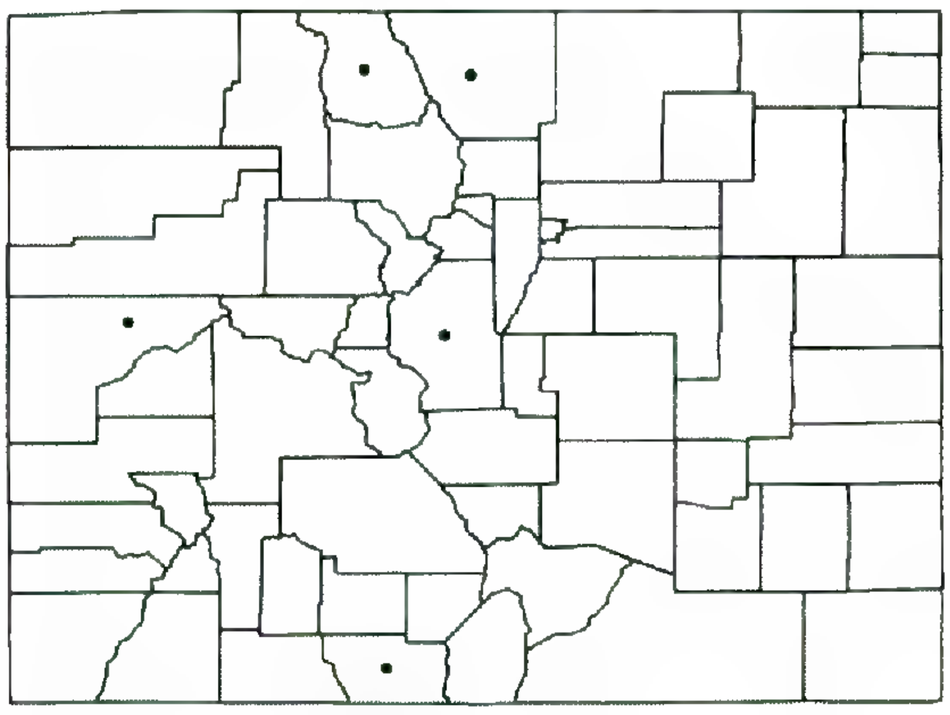
The shape and texture of basal leaves have long been of key taxonomic importance in the genus. The shape of the blade, base of the blade, and blade margins are the three most important characters. In general the basal leaves are



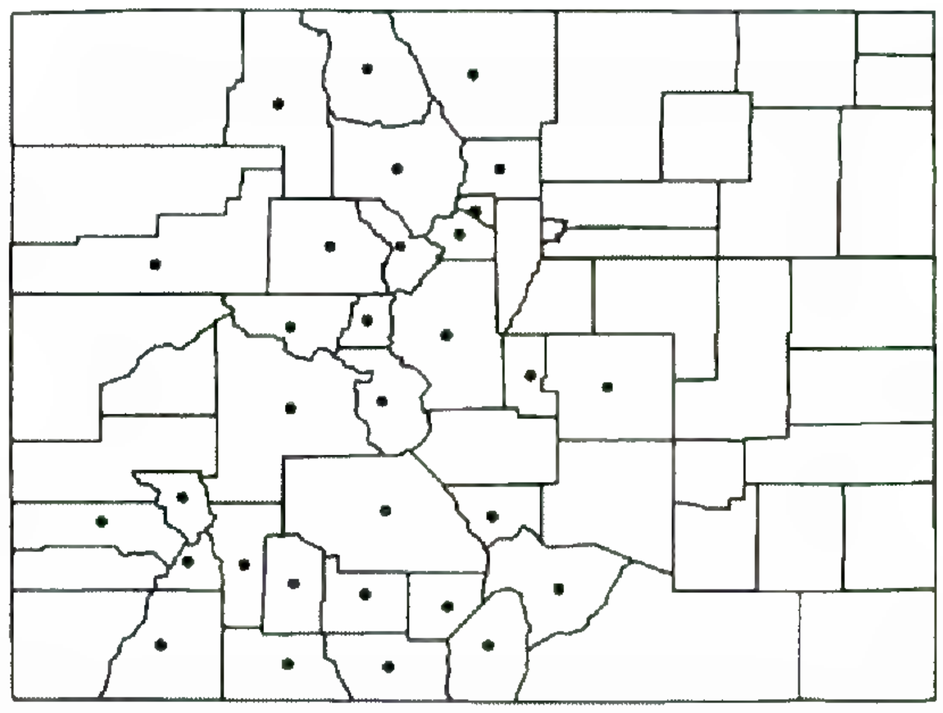
Packera cana



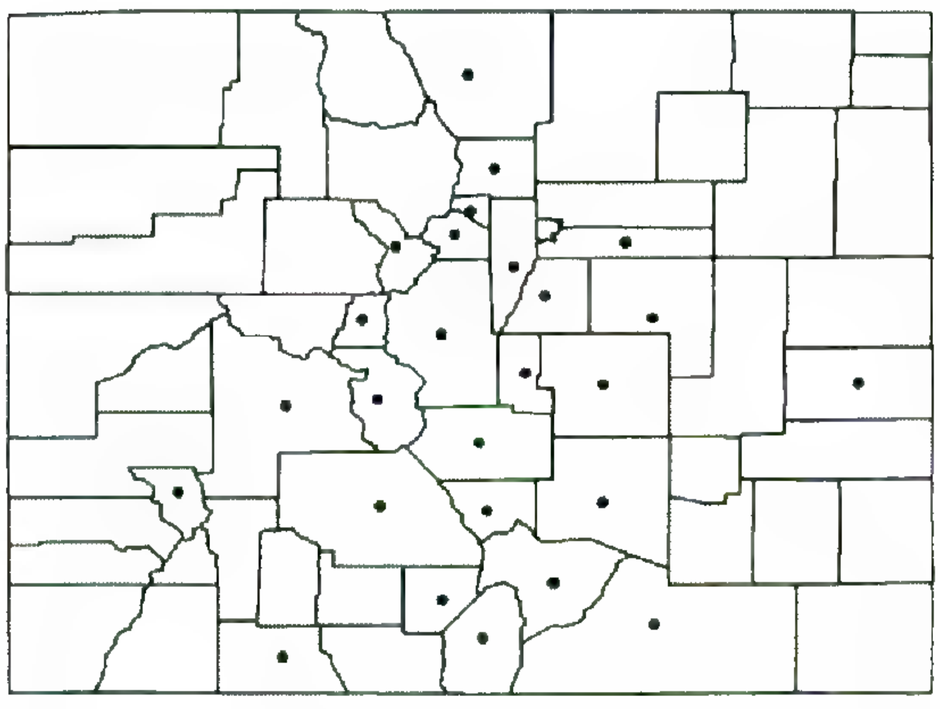
Packera crocata



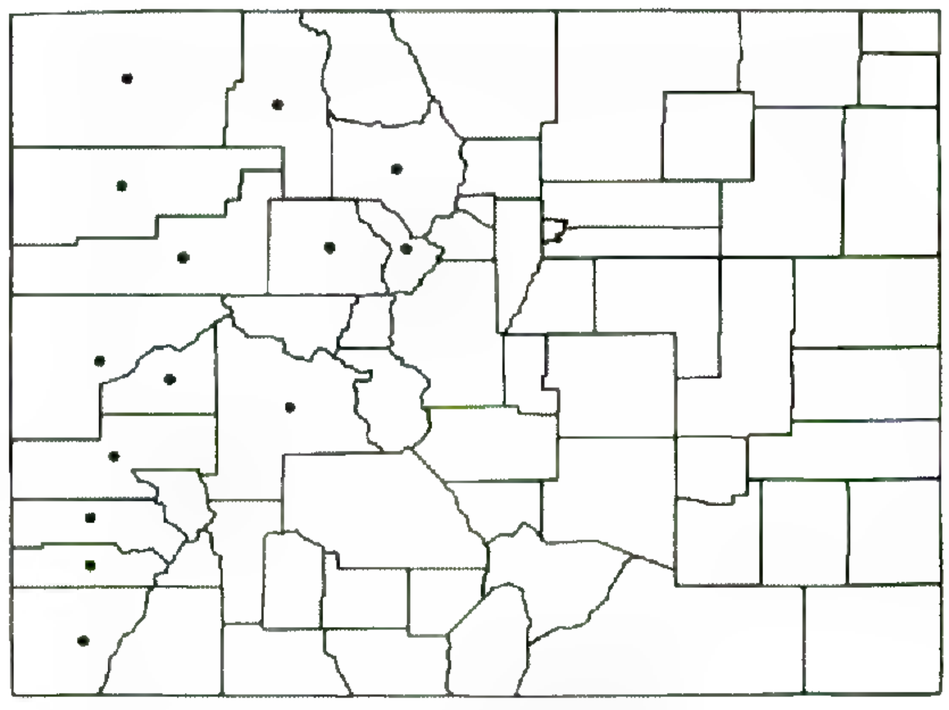
Packera debilis



Packera dimorphophylla var. dimorphophylla



Packera fendleri

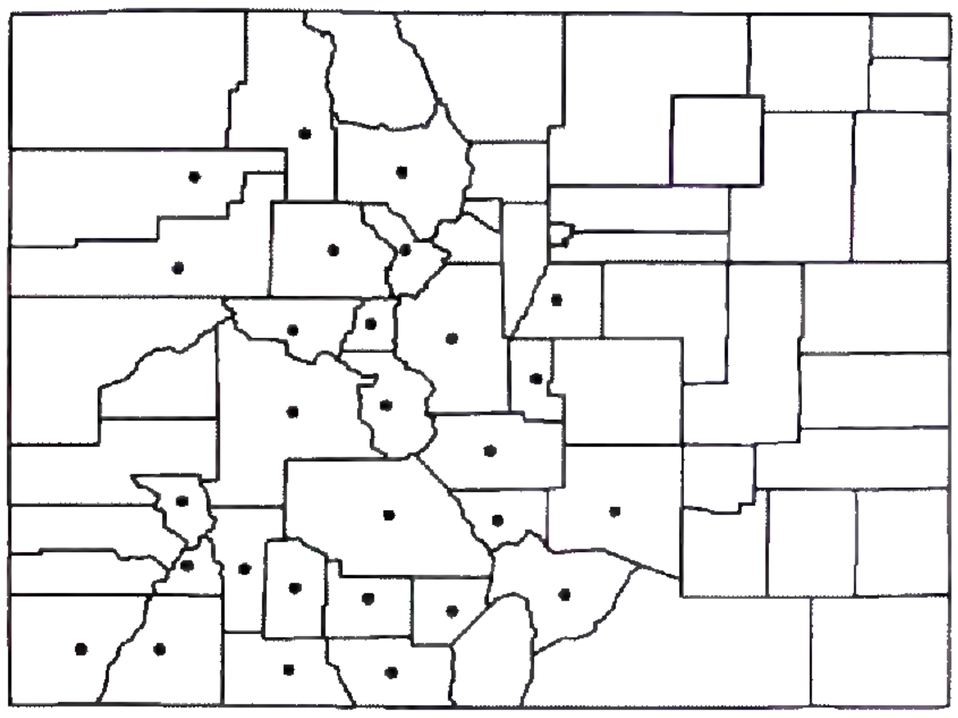


Packera multilobata

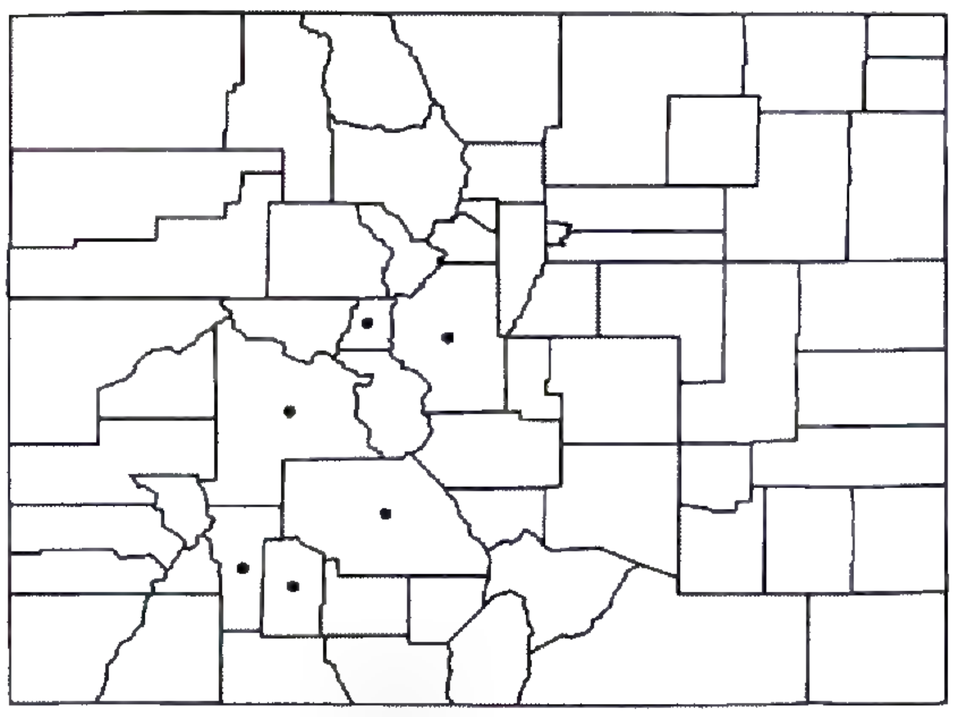
FIG. 1. Distribution maps for *Packera* species in Colorado. The records for each county are supported by at least one voucher specimen deposited in the herbaria cited in this paper.

petiolate. The only exception among Colorado Packeras is *P. werneriifolia*. Some individuals of this species have basal leaves that are sessile.

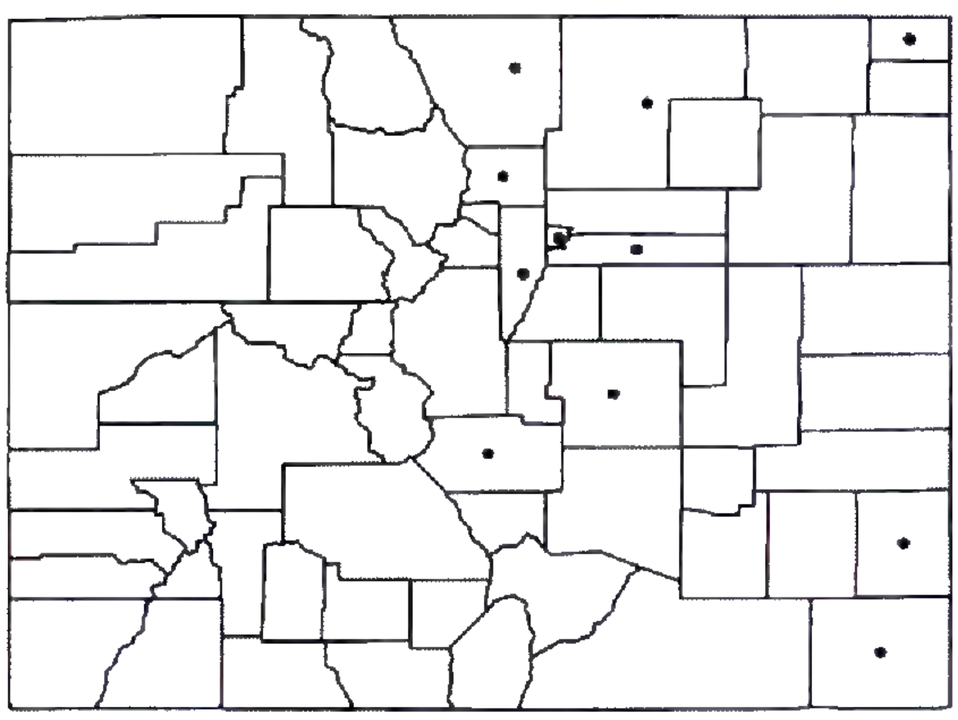
The shape and size of cauline leaves can also be useful, but there may be extreme variability within species. In all species of *Packera*, the basal leaves are arranged in rosettes, while the cauline leaves are either gradually, progres-



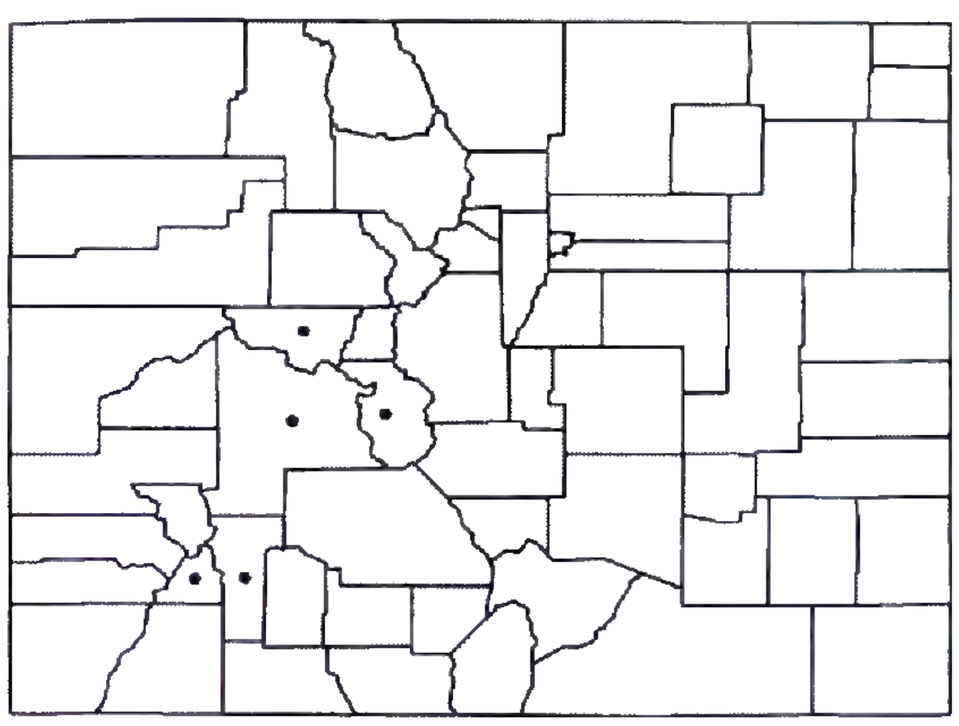
Packera neomexicanavar. mutabilis



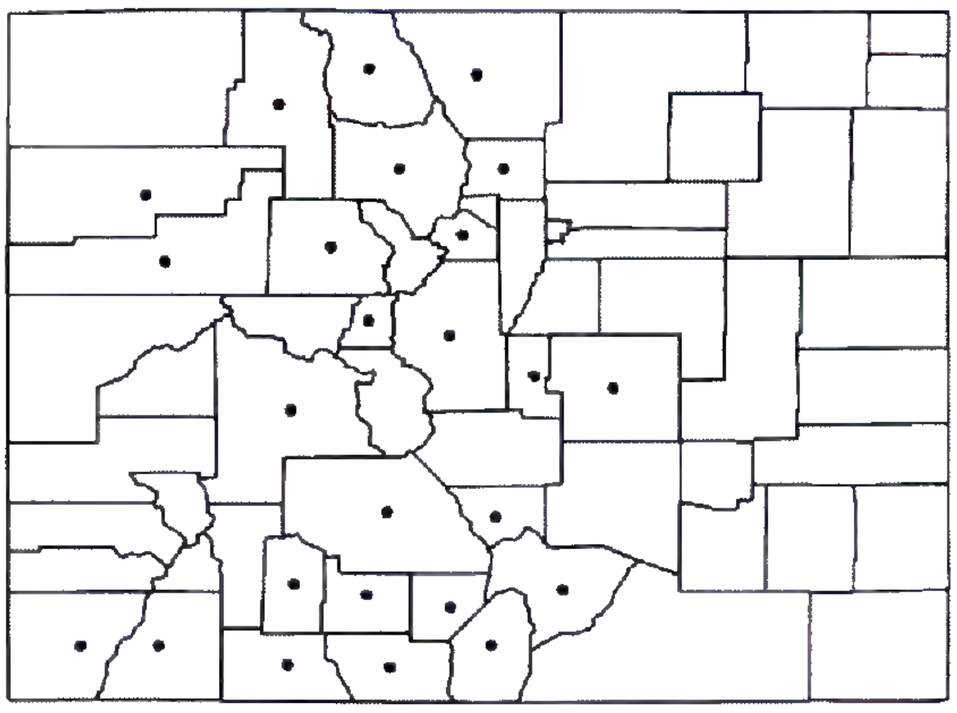
Packera paupercula



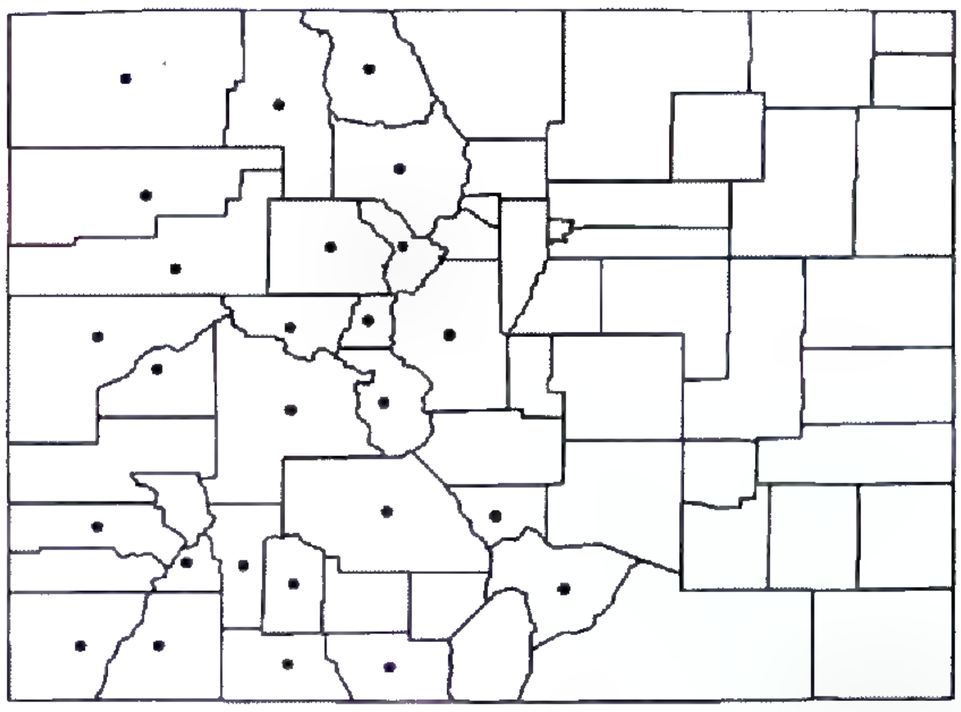
Packera plattensis



Packera porteri



Packera pseudaurea var. flavula



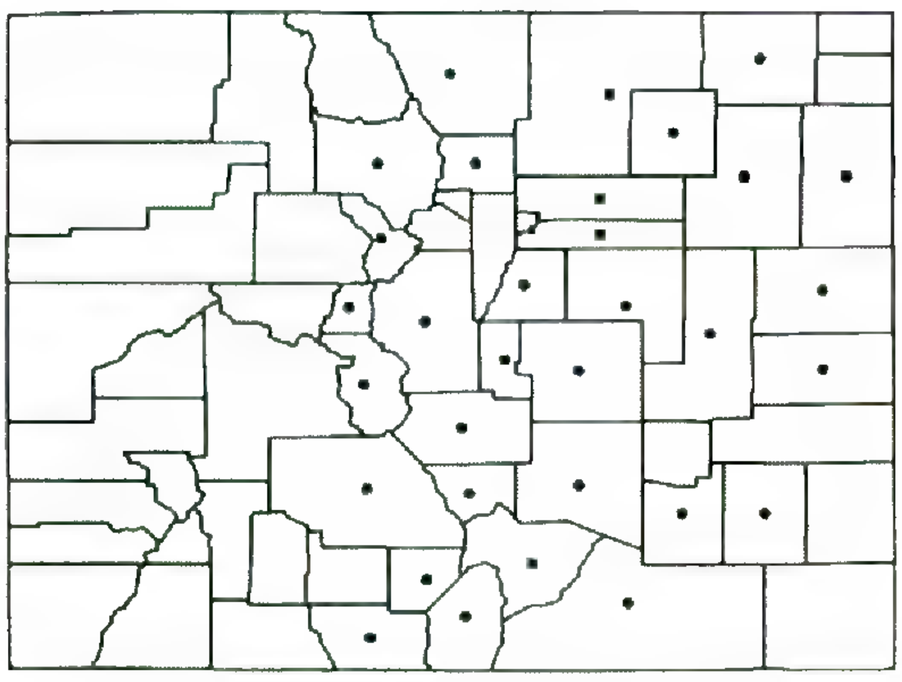
Packera streptanthifoliavar. streptanthifolia

FIG. 2. Distribution maps for *Packera* species in Colorado (continued).

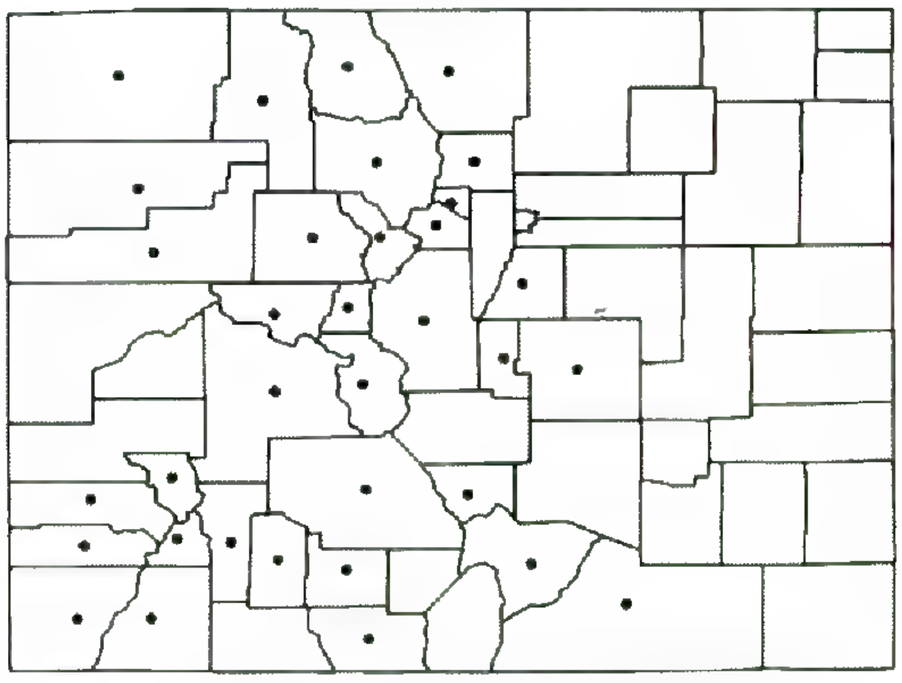
sively, or abruptly reduced upwards on the stem. In all species, the uppermost cauline leaves are sessile and most are bract-like.

The heads in the inflorescence are arranged in either subumbellate or corymbiform cymes. Two species (*P. porteri* and *P. werneriifolia*) nearly always have only one large terminal head or at most two or three smaller heads.

Most species of *Packera* have 8 or 10 or 13 ray florets per head. However, *P.*



Packera tridenticulata



Packera werneriifolia

Fig. 3. Distribution maps for *Packera* species in Colorado (continued).

debilis, is typically rayless. A few others, including *P. paupercula*, *P. porteri*, *P. pseudaurea*, and *P. werneriifolia* are occasionally rayless. In most species the florets are a bright yellow. *P. dimorphophylla var. dimorphophylla* and *P. crocata* frequently have florets that are deep orange-yellow to almost brick-red. *P. streptanthifolia* may have rays that are a deep orange-yellow as well.

Another character that is frequently used in descriptions is size and pubescence of the cypselae. While there is variation in size, *P. cana* has noticeably large fruits and *P. dimorphophylla* has noticeably small ones. Many species have glabrous fruits, but a few have tiny hairs along the ribs of the cypselae.

KEY TO THE PACKERAS OF COLORADO

1. Plants distinctly tomentose throughout, or occasionally glabrate.
   2. Margins of leaf blades shallowly but evenly pinnatifid to pinnatisect or merely wavy _____ **P. fendleri**
   2. Margins of leaf blades variously entire or dentate, but not pinnatifid.
      3. Plants with 1–3(–5) large heads, alpine to sub-alpine, scapose or with cauline leaves reduced to mere bracts _____ **P. werneriifolia**
      3. Plants without the above combination of characters.
         4. Plants persistently lanate or canescent, leaf blades ovate or elliptic, or rarely broadly lanceolate, leaf margins entire or merely wavy _____ **P. cana**
         4. Plants with persistent dense tomentum at least at the base of the stem and in leaf axils. Lightly tomentose elsewnere, glabrescent with age.
            5. Basal leaves lanceolate, oblanceolate or narrowly elliptic, lower cauline leaves similar to basal leaves, calyculate bracts long and conspicuous. Plants of open meadows and coniferous woodlands at mid to high elevation _____ **P. neomexicana** var. **mutabilis**
            5. Basal leaves elliptic to ovate or oblanceolate, lower cauline leaves lyrate to pinnatisect, calyculate bracts few and inconspicuous. Plants of open prairies and grasslands _____ **P. plattensis**
1. Plants glabrous, may be tomentose when young, or persistently so in the axils of the leaves and at the base of the stem; or rarely lightly pubescent throughout.
   6. Heads rayless or ray florets much reduced, involucres greenish with anthocyanic

tips; lower and mid-cauline leaves pinnately lobed with deep rounded sinuses _____ **P. debilis**

6. Heads radiate, or if rays lacking only 1 head per stem and involucres deeply anthocyanic.
   7. Plants with a single large head; involucres deeply anthocyanic, basal leaves reniform to subreniform, cauline leaves reduced to bracts, plants of alpine scree slopes _____ **P. porteri**
   7. Plants with few to several heads, involucres and leaves without the above combination of characters.
      8. Basal leaf blades narrowly to broadly lanceolate, oblanceolate or narrowly elliptic.
         9. Lower cauline leaves similar to basal leaves, upper ones becoming sessile; calyculate bracts conspicuous and numerous but small; cypselae hirtel lous along the angles; plants of prairies and sagebrush habitats _____ **P. tridenticulata**
         9. Lower cauline leaves various; calyculate bracts either few and inconspicuous or large and conspicuous; cypselae glabrous; plants of mountain or wet meadow habitats.
            10. Involucres dark green, often with anthocyanic tips; heads with nu merous large conspicuous calyculate bracts _____ **P. streptanthifolia** var. **streptanthifolia**
            10. Involucres light green, tips not distinctly anthocyanic; calyculate bracts few and inconspicuous.
               11. Leaf blades broadly lanceolate to ovate; base of leaf blades truncate to subcordate or occasionally obtuse; lower cauline leaves sublyrate to subentire; middle and upper cauline leaves sessile and frequently clasping _____ **P. pseudaurea** var. **flavula**
               11. Leaf blades lanceolate to narrowly elliptic; base of leaf blades tapering to cuneate or obtuse, but never subcordate; lower cauline leaves often sublyrate or with margins variously dissected, but rarely subentire; middle and upper cauline leaves mere sessile bracts _____ **P. paupercula**
      8. Basal leaf blades broadly elliptic, obovate or oblanceolate to ovate or orbicular.
         12. Leaf margins lobed or pinnatifid; plants of sandy sagebrush habitats _____ **P. multilobata**
         12. Leaf margins variously dentate to crenate or shallowly lobed but never pinnatifid; plants of alpine to subalpine habitats.
            13. Lower and middle cauline leaves sessile, conspicuously clasping and auriculate _____ **P. dimorphophylla** var. **dimorphophylla**
            13. Lower and middle cauline leaves sessile or petiolate, may be weakly clasping but never auriculate.
               14. Leaf blades thin, margins entire to weakly crenate or merely wavy; upper cauline leaves sessile and weakly clasping; rays often deep orange yellow or brick red; calyculate bracts few or absent; plants of sub-alpine meadows _____ **P. crocata**
               14. Leaf blades thick and turgid, margins variously entire to conspicuously dentate; upper cauline leaves sessile and reduced to mere bracts; rays deep yellow, but never reddish; calyculate bracts conspicuous; habitats from damp to drying ____ **P. streptanthifolia** var. **streptanthifolia**

SPECIES DESCRIPTIONS AND COMMENTS ON IDENTIFICATION

Packera cana (Hook.) W.A. Weber & A. Löve, Phytologia. 49:46. 1981. *Senecio canus* Hook.

Senecio purshianus Nutt.; *Senecio canus* var. *purshianus* A. Nelson; *Senecio canus* var. *eradiatus* D.C.; *Senecio howellii* Greene; *Senecio hallii* Britton; *Senecio harbourii* Rydb.; *Senecio convallium* Greenm.; *Senecio oreopolus* Greenm.; *Senecio hallii* var. *discoidea* W.A. Weber

Perennials. **Caudices** stout, branching rhizomatous, suberect. **Stems** single from a rosette, or clustered rosettes, densely lanate-pubescent or canescent. **Basal leaves** petiolate, blades ovate or elliptic to lanceolate, 2.5–5+ × 1–3 cm, bases tapering, margins entire or irregularly undulate to weakly dentate, persistently canescent on lower surface, canescent to subglabrescent on upper surface. **Cauline leaves** petiolate to sessile and weakly clasping, progressively reduced distally, elliptic to lanceolate, margins entire to weakly dentate. **Heads** radiate, 8–15+ in corymbiform arrays. Peduncles bracteolate, densely lanate to floccose tomentose, subglabrescent in some populations. **Calyculi** present, inconspicuous, tomentose. **Phyllaries** 13 or 21, green, 5–8+ mm, densely tomentose. **Ray florets** 8–10 or 13, laminae 8–10+ mm. **Disc florets** 35–50+; corolla tubes 2.5–3.5 mm, limbs 3.5–4.5 mm. **Cypselae** 2.5–3.5+ mm long, glabrous, pappi 4.5–7 mm long. 2n=46.

Packera cana is found on open high plains and in sagebrush associations. It is also collected from dry rocky slopes and from crevices on both granitic and limestone outcrops. It flowers from late June into August, depending on latitude and elevation and is very abundant in Colorado. Although this species is found on grasslands in Wyoming, Montana, North Dakota, South Dakota, and Nebraska, it is rarely found on the high plains of the eastern part of Colorado.

Probably the only other species in Colorado with which it can be confused is *P. werneriifolia*. Two features contribute to this potential confusion: 1) At very high elevations *P. cana* may be very short (< 10 cm); 2) *P. werneriifolia* can be nearly as pubescent as *P. cana*.

There are two features distinguishing these two species: 1) *P. cana* nearly always has more than 3 heads in the inflorescence. At high elevations the inflorescence is often very compact, and the heads are small. *Packera werneriifolia*, on the other hand, normally has only 1 or two large heads. It can occasionally have 3–5 heads, in which case they are smaller than normal. 2) *P. cana* always has some cauline leaves even if they are very reduced and mostly on the lower portion of the stem, while *P. werneriifolia* is nearly always scapose, or in some very robust specimens, may have a few bract-like leaves on the stem.

Packera crocata (Rydb.) Weber & Löve, Phytologia. 49:46. 1981. *Senecio crocatus* Rydb.

Senecio aureus var. *croceus* A. Gray; *Senecio pyrrochrous* Greene; *Senecio tracyi* Rydb.

Perennials. **Caudices** long, stout, horizontal to ascending. **Stems** 2–6+ dm, single or rarely 2–3 clustered, glabrous. **Basal leaves** thin petiolate, blades narrowly lanceolate or ovate to oblong ovate, 2–6+ × 1–4+ cm, bases abruptly contracted

to tapering, margins subentire to crenate-dentate. **Cauline leaves** petiolate to sessile and weakly clasping, progressively reduced distally, lanceolate to oblong, margins sublyrate or lobed. **Heads** radiate, 7–15+ in open corymbiform arrays. Peduncles absent or small and inconspicuous, glabrous. **Calyculi** absent or few and small. **Phyllaries** 13 or 21, light green or with reddish tips, 4–8 mm, glabrous. **Ray florets** 8 or 13, corolla laminae 6–8+ mm, deep yellow to orange-red. **Disc florets** 60–80+; corolla tubes 4.5–5.5 mm, limbs 2.5–3.5 mm. **Cypselae** 1–1.5 mm long, glabrous, pappi 3–5 mm long. 2n=46.

This species grows in wet meadows often associated with grasses, sedges and willows, along trails and in rocky outcrops at middle to subalpine elevations and flowers from early July to mid-August. The only species that it may be confused with is *P. dimorphophylla* var. *dimorphophylla*. Three features distinguish these two species: 1) *P. crocata* has an open inflorescence, while that of *P. dimorphophylla* var. *dimorphophylla* is compact and congested. 2) *P. dimorphophylla* has dramatically large, auriculate, and conspicuously clasping middle and upper cauline leaves. While *P. crocata* may have larger than normal cauline leaves, they are at most weakly clasping. 3) While both species generally grow in wet places, *P. crocata* grows at elevations of ca. 8,000 – 10,000 feet and is fairly tall and thin, while *P. dimorphophylla* var. *dimorphophylla* is almost never found below 10,000 feet and is normally a more compact plant.

It is frequently noted in the literature that *P. crocata* has orange to reddish ray florets. However, *P. crocata* sometimes produces deep yellow ray florets, and *P. dimorphophylla* var. *dimorphophylla* may produce orangish ray florets.

Packera debilis (Nutt.) W.A. Weber & A. Löve, Phytologia. 49:46. 1981. *Senecio debilis* Nutt.

Senecio fedifolius Rydb.

Perennials. **Caudices** short, weakly branching. **Stems** 20–50+, single or 2–4 clustered, bases lightly floccose-tomentose or glabrous, leaf axils tomentose. **Basal leaves** petiolate and turgid, blades elliptic to ovate or subreniform, 2–4+ cm × 1.5–3+ cm, bases cuneate to subcordate, margins subentire or crenate to crenate-dentate. **Cauline leaves** petiolate to sessile, progressively reduced distally, blades pinnate-lobed, sinuses deep and rounded, lobes with entire to subentire margins. **Heads** eradiate, 6–20+ in open or compact corymbiform arrays. Peduncles present, short and conspicuous or absent, glabrous or lightly pubescent. **Calyculi** present, few and inconspicuous. **Phyllaries** 13 or 21, green with reddish tips, 6–8+ mm, glabrous. **Ray florets** absent. **Disc florets** 45–65+, corolla tubes 3–4 mm, limbs 2–3 mm. **Cypselae** 1–2 mm long, glabrous, pappi 4.5–5.5 mm long. 2n=46.

This is a distinctive plant of central and northern Colorado. It is collected frequently in Park County and less frequently in northern counties at mid to subalpine elevations in open meadows with alkaline soils. *Packera debilis* is sometimes identified as *P. pauciflora*, which is also a rayless plant with reddish

involucres. However, *P. pauciflora* is a plant with a more northerly distribution (it does not occur in Colorado) and a suite of characteristics that distinguish it from *P. debilis*. 1) *Packera debilis* generally has more than 6 heads in the inflorescence while *P. pauciflora* normally has 6 or fewer large heads. 2) *Packera debilis* has very short bracteoles on the peduncles, while *P. pauciflora* has very large conspicuous ones. 3) *Packera debilis*, has very few greenish, inconspicuous calyculate bracts. *P. pauciflora*, on the other hand, has long calyculate bracts that are normally quite reddish in color or at least have red tips. 4) The involucral bracts of *P. debilis* may display reddish coloration on the upper one-half to one-third of the tips, but the involucres of *P. pauciflora* are normally deeply anthocyanic throughout. 5) Probably the most easily distinguished characteristic concerns the lobing of the mid-cauline leaves. The terminal lobe of the leaves on *P. debilis* is narrow and pointed, and the sinuses of the individual lobes are deep and rounded.

Although *P. debilis* has been known at least from Park, Larimer, and Jackson counties for many years, it is very infrequently collected and is confined to alkaline meadow habitats. It may indeed be worthy of special note, and an effort should be made to document existing populations.

Packera dimorphophylla (Greene) var. **dimorphophylla** W.A. Weber & A. Löve, Phytologia. 49:46. 1981. *Senecio dimorphophyllus* Greene var. *dimorphophyllus*.

Perennials. **Caudices** short, stout, fibrous-rooted, horizontal to erect. **Stems** 1–3+ dm, single or rarely 2–3 clustered, simple or branched, glabrous. **Leaves:** basal leaves petiolate, thick and turgid, blades varying from ovate to subreniform or occasionally oblanceolate, bases tapering to a broad-winged petiole, margins entire to crenate; lower and mid-cauline leaves sessile, conspicuously clasping and auriculate, blades as large or larger than basal leaves, oblanceolate, obovate or lyrate, margins subentire to bluntly and irregularly dissected; upper cauline leaves usually reduced to sessile bracts, occasionally large and conspicuous. **Heads** radiate, 1–6+ in congested corymbiform or subumbellate arrays. Peduncles inconspicuously bracteolate or bracteoles absent, glabrous. **Calyculi** conspicuous, bases swollen. **Phyllaries** 13 or 21, occasionally fewer, green with anthocyanic apices, 5–7+ mm, glabrous. **Ray florets** 8 or 13, deep yellow to orange, corolla laminae 5–8+ mm. **Disc florets** 45–60+, corolla tubes 2–3 mm, limbs 2.5–3.5 mm. **Cypselae** 0.75–1.5 mm long, glabrous, pappi 3–4 mm long. 2n = 46.

This species is quite distinctive and is only rarely confused with one other entity in Colorado, *P. crocata*. A discussion of the characters used to separate the two species is found with the description of *P. crocata*. It is found at elevations generally over 10,000 feet in damp meadows or in seeps and crevices on hillsides. It flowers from early July to mid-August.

Packera fendleri (A. Gray) W.A. Weber & A. Löve, Phytologia. 49:46. 1981. *Senecio fendleri* A. Gray

Senecio nelsonii Rydb.; *Senecio salicinus* Rydb.; *Senecio canovirens* Rydb.; *Senecio rosulatus* Rydb.; *Senecio fendleri* var. *molestus* Greenm.

Perennials. **Caudices** rhizomatous, prominent lateral branches, horizontal to suberect. **Stems** 1–4+ dm, single or crowded to subcaespitose in some populations, floccose-tomentose or glabrescent. **Basal leaves** petiolate, blades lanceolate to oblanceolate, 3–6+ × 1–3+ cm, bases tapering, margins shallowly but evenly pinnatifid to pinnatisect or merely wavy, permanently floccose-tomentose or subglabrescent on upper surface. **Cauline leaves** sessile, gradually reduced distally, lanceolate to oblanceolate, margins pinnatisect to wavy. **Heads** radiate, 6–25+ in open or compact corymbiform arrays. Peduncles with numerous small bracteoles, heavily to irregularly floccose. **Calyculi** present but few and short, red tinged. **Phyllaries** 13, green, 5–7 mm, floccose proximally to glabrescent distally. **Ray florets** 6–8+, corolla laminae 5–7 mm. **Disc florets** 30–40+; corolla tubes 2.5–3 mm, limbs, 2.5–3.5 mm. **Cypselae** 2.5–3 mm long, glabrous, pappi 4–5 mm long. 2n=46.

This species is rarely confused with other Colorado Packeras. Some individuals, with merely wavy leaves could be mistaken for *P. cana*, but close inspection should easily separate the two. *Packera fendleri* is very abundant and almost weedy where it occurs. It prefers steep slopes in loose, dry rocky or gravelly soil, streamsides, open forested areas, and disturbed sites such as roadsides and picnic areas. It flowers any time between the end of May and early October throughout its range, depending on elevation.

Packera multilobata (Torr. & A. Gray ex A. Gray) W.A. Weber & A. Löve, Phytologia. 49:47. 1981. *Senecio multilobatus* Torr. & A. Gray ex. A. Gray

Senecio lynceus Greene; *Senecio nelsonii* var. *uintahensis* A. Nelson; *Senecio uintahensis* Greenm.; *Senecio stygius* Greene; *Senecio prolixus* Greenm.; *Senecio leucoreus* Greenm.; *Senecio thornberi* Greenm.

Perennials or biennials. **Caudices** weakly branching, taprooted, ascending to erect. **Stems** 2–4+ dm, single or 2–5 loosely clustered, glabrous or glabrescent, occasionally lightly tomentose throughout, axils of basal leaves with tufts of tomentum. **Leaves:** basal and lower cauline leaves petiolate, blades obovate, oblanceolate or spatulate, 4–8+ × 1–3+ cm, bases tapering, margins deeply pinnatifid or lyrate to sublyrate, leaf segments variously toothed and rounded; middle and upper cauline leaves progressively reduced distally, sessile. **Heads** radiate, 10–30+ in open corymbiform or subumbellate arrays. Peduncles conspicuously bracteolate, glabrous or with tufts of tomentum. **Calyculi** present and obvious. **Phyllaries** 13–21, green often with yellow tips, 4–9+ mm, glabrous to lightly tomentose proximally. **Ray florets** 8–13, corolla laminae 7–10 mm. **Disc florets** 40–50+, corolla tubes 4–5 mm, limbs 3–4 mm. **Cypselae** 2–3 mm long, glabrous or hirtellous on the angles, pappi 5–6 mm long. 2n = 46 or 92

This species is also rarely confused with any others in Colorado. *P.*

multilobata and *P. fendleri* are the only distinctly lobed or pinnatifid Packeras in the state. *Packera fendleri* is consistently very pubescent and *P. multilobata* is nearly always glabrous. *Packera multilobata* occurs on the western slope but thus far has not been recorded from counties along the Rocky Mountain Front. It prefers dry rocky or sandy substrates in habitats as varied as desert sagebrush, juniper woodlands, and subalpine forests. It flowers in early May at lower elevations and as late as mid-July at higher elevations.

Packera neomexicana (Greene) var. **mutabilis** W.A. Weber & A. Löve, Phytologia. 49:47. 1981. *Senecio mutabilis* Greene; *Senecio neomexicanus* var. *mutabilis* (Greene) T.M. Barkley.

Perennials. **Caudices** branched, weakly spreading, horizontal or ascending to erect. **Stems** 2–5+ dm, single or 2–3 clustered, densely lanate or arachnoid tomentose or glabrescent. **Basal leaves** petiolate, blades lanceolate or narrowly lanceolate, 2–6+ × 1–3+ cm, bases tapering, margins subentire to dentate, permanently but loosely tomentose throughout. **Cauline leaves** progressively reduced distally; lower leaves petiolate and similar to basal leaves; mid to upper cauline leaves becoming sessile, blades lanceolate, margins entire. **Heads** radiate, 3–20+ in open or compact corymbiform to subumbelliform arrays, subtended by smaller cymes arising from leaf axils. Peduncles conspicuously bracteolate, normally pubescent. **Caylculi** present and conspicuous. **Phyllaries** 13 or 21, green or yellowish, 4–7 mm, tomentose to glabrescent. **Ray florets** 8 or 13, occasionally 5, corolla laminae 4–10 mm. **Disc florets** 40–60+, corolla tubes 1.5–2.5 mm, limbs 3.5–4.5 mm. **Cypselae** 1.5–2.5 mm long, hirtellous on the angles or infrequently glabrous, pappi 5–6+ mm long. 2n = 46 or 92

This species flowers from late April to mid-July. It is frequently confused with *Packera tridenticulata*. Four characteristics, when taken in combination, can help to distinguish these two entities.

1) *P. tridenticulata* is a plant of the high plains and foothills in Colorado. In a few cases, it has apparently "jumped" the Rocky Mountain Front and has been collected growing in some of the interior valleys, usually in grassland/sagebrush associations. On the other hand, *P. neomexicana* var. *mutabilis* is generally found growing in rocky soils in open meadows and coniferous woodlands at high elevations.

2) *P. tridenticulata* usually grows in obvious clumps from a stout taprooted caudex, while *P. neomexicana* var. *mutabilis* normally has no more than 2–3 stems arising from a branching caudex.

3) *P. tridenticulata* tends to have slightly smaller achenes that are normally glabrous or at most lightly hirtellous along the angles, while *P. neomexicana* var. *mutabilis* has achenes that are a bit larger and normally distinctly hirtellous along the angles.

4) *P. tridenticulata* collected from the eastern part of its range is always glabrous. In the western part of its range, and in the interior valleys west of the Rocky Mountain Front, entities that would otherwise be easily identified as *P. tridenticulata* often show some very light pubescence at stem bases and in leaf axils. *Packera neomexicana* var. *mutabilis* is always loosely but persistently tomentose at least at the base of the stem, in the axils of the leaves, and at the base of the inflorescence. The lower leaf blades are also almost always lightly pubescent.

The center of distribution for *P. neomexicana* var. *mutabilis* is in the four-corners region, while *P. tridenticulata* is primarily a plant of the high plains and short-grass prairies. There is good evidence for hybridization between these two entities, primarily in the high valleys around Alamosa in south-central Colorado. There are several specimens in the herbaria at Adams State College in Alamosa and Colorado College in Colorado Springs with characters that are intermediate between *P. neomexicana* and *P. tridenticulata*. Several specimens display all the characteristics of *P. tridenticulata*, but are unusually and persistently tomentose, while others that are obviously glabrous have hirtellous achenes. Biosystematic work on these two species throughout the central valleys of Colorado would undoubtedly shed light on the complicated relationships in this complex.

Packera neomexicana var. *mutabilis* is infrequently confused, with *P. streptanthifolia* and *P. fendleri*. Some specimens of *P. fendleri* with merely wavy leaves and less than the normal amount of tomentum have been misidentified as *P. neomexicana* var. *mutabilis*. *Packera streptanthifolia* is a highly variable species with a number of identifiable "phases." The narrow-leaved phase of *P. streptanthifolia* is sometimes difficult to distinguish, but once again, careful observation of a combination of characters should provide accurate identifications.

Packera paupercula (Michx.) Löve & Löve, Bot. Not. 128:520. 1976. *Senecio pauperculus* Michx.

Senecio balsamitae Muhl. ex Willd.; *Senecio flavovirens* Rydb.; *Senecio crawfordii* Britton; *Senecio tweedyi* Rydb.; *Senecio multnomensis* Greenm.; *Senecio gaspensis* Greenm.

Perennials. **Caudices** sub-rhizomatous, weakly branching, ascending to erect. **Stems** 2–4.5+ dm, single or 2–4 loosely clustered, glabrous or lightly tomentose proximally. **Leaves**: basal leaves petiolate, blades lanceolate to narrowly elliptic or oblanceolate, 3–6+ × 1–2+ cm, bases tapering to cuneate or obtuse, margins subentire to variously dentate or serrate. Cauline leaves progressively reduced distally; lower ones petiolate, blades sublyrate; middle ones sessile, blades lanceolate, margins variously dissected, incised or lacerate; upper ones sessile bracts. **Heads** radiate, 2–10+ in loose or compact corymbiform arrays. Peduncles bracteolate or bracteoles occasionally absent, glabrous. **Calyculi** present and inconspicuous. **Phyllaries** 13 or 21, green, 5–8+ mm, glabrous. **Ray florets** 8 or 13, or occasionally absent, corolla laminae 5–10+ mm. **Disc florets** 50–65+, corolla

tubes 2–3 mm, limbs 2–3 mm. **Cypselae** 1–2 mm long, glabrous or occasionally hispidulous on the angles, pappi 3.5–4.5 mm long. 2n = 44 or 46.

Packera paupercula is the most ecologically and morphologically variable *Packera* in North America. Although widespread, it has been infrequently collected in Colorado. It flowers from late June to late July in Colorado and can be found in wet meadows, open woodlands, and along streambanks. In areas of sympatry, *P. paupercula* can be confused with *P. plattensis*, but that is not a problem in Colorado because *P. plattensis* is confined to the high plains and *P. paupercula* has only been collected from mountainous regions.

The other species with which *P. paupercula* could easily be confused is *P. pseudaurea* var. *flavula*. There are six characteristics that can be used in combination to separate these two entities: 1) Basal and lower leaf blades of *P. paupercula* are lanceolate to narrowly elliptic, and normally 1.5–3 times longer than wide. Those of *P. pseudaurea* var. *flavula* are broadly lanceolate to ovate, and 1–2 times longer than wide; 2) Bases of the leaf blades of *P. paupercula* are tapering, those of the *P. pseudaurea* var. *flavula* are truncate to subcordate; 3) Upper cauline leaves of the former are sessile, those of the latter are weakly clasping; 4) Phyllaries of *P. paupercula* specimens from Colorado normally number 13 and are 5–8 mm long, those of *P. pseudaurea* var. *flavula* usually number 21 and are 3–5 mm long; 5) *P. paupercula* normally has 40–50 disc florets in a one head, *P. pseudaurea* var. *flavula* has 60–80; 6) Corolla tubes of the disc florets in *P. paupercula* are about the same length as the limbs, 2–3 mm, however in *P. pseudaurea* var. *flavula*, the corolla tubes are much longer than the limbs, 3.5–4.5 mm and 2–3 mm, respectively.

Packera plattensis (Nutt.) W.A. Weber & Löve, Phytologia. 49:48. 1981. *Senecio plattensis* Nutt.

Senecio pseudotomentosus Mackenzie & Bush.

Perennials or biennials. **Caudices** stoloniferous in eastern populations, fibrous rooted elsewhere, erect or suberect. **Stems** 2–6+ dm, single or 2–3 clustered, persistently floccose-tomentose proximally and in leaf axils, lightly tomentose or glabrescent elsewhere. **Leaves:** basal and lower cauline leaves petiolate, blades narrowly elliptic to elliptic-ovate or oblanceolate to suborbicular, abaxial surface subpersistently floccose-tomentose, especially along the mid-vein, 2–7+ × 1–3+ cm, bases tapering to rounded or abruptly contracted, margins subentire to crenate, serrate-dentate, or sublyrate; middle cauline leaves progressively reduced distally, short petiolate, blades sub-lyrate to pinnatisect, lightly pubescent on the abaxial surface; upper cauline leaves, sessile, subentire to irregularly dissected. **Heads** radiate, 6–20+ in open or congested corymbiform arrays. Peduncles abundantly bracteolate, lightly to heavily tomentose. **Calyculi** numerous but inconspicuous. **Phyllaries** 13 or 21, green or occasionally with reddish tips, 5–6+ mm, densely tomentose distally, glabrescent above. **Ray florets**

8–10, corolla laminae 9–10 mm. **Disc florets** 60–70+, corolla tubes 2.5–3.5 mm, limbs 3.5–4.5 mm. **Cypselae** 1.5–2.5 mm long, hirtellous or occasionally glabrous, pappi, 6.5–7.5 mm long. 2n = 46 or 92.

Packera plattensis inhabits rocky, gravelly, or sandy/loam soils in open prairies and grasslands. It is found throughout eastern Colorado but in dry years may not be abundant. It occurs in the foothills of the Front Range, but to my knowledge has never been collected further west than that. *Packera plattensis* flowers from mid-May to mid-June in Colorado. The only other high plains *Packera* species in Colorado is *P. tridenticulata*, and these two species are rarely confused. *Packera plattensis* is always densely floccose-tomentose at the base of the stem and in the leaf axils and often persistently lightly tomentose elsewhere. *Packera tridenticulata* collected on the high plains is nearly always glabrous or at most very lightly tomentose at the base of the stem.

Packera porteri (Greene) C. Jeffrey, Kew Bull. 47:101. 1992. *Senecio porteri* Greene; *Ligularia porteri* (Greene) W.A. Weber

Senecio renifolius Porter; *Senecio aureus* var. *alpinus* A. Gray.

Perennials. **Caudices** with long slender branching rhizomes. **Stems** 3–10+ cm, single, often anthocyanic, glabrous. **Leaves**: basal leaves petiolate and turgid, blades reniform to sub-reniform, 0.5–1.5+ × 0.5–2.5+ cm, abaxial surface distinctly anthocyanic, bases abruptly contracted to cordate, margins distinctly crenate or occasionally wavy; cauline leaves abruptly reduced distally to 1–4 sessile bracts with entire margins. **Heads** radiate, 1 large terminal head, 10–15+ mm high. **Calyculi** present and conspicuous, often anthocyanic. **Phyllaries** 13 or 21, deep red, 8–10+ mm, glabrous. **Ray florets** 8 or 13, corolla laminae 8–10+ mm. **Disc florets** 40–50+, corolla tubes 2.5–3.5 mm, limbs 2.5–3.5 mm. **Cypselae** 1.5–2.5 mm long, glabrous, pappi 4–5.5 mm long.

Packera porteri is undoubtedly the most morphologically distinctive *Packera* in Colorado and the most restricted in range and habitat. It is confined to steep talus slopes in alpine habitats, rarely below 11,000 feet. It is most frequently collected west of the Continental Divide in two general locations: Gunnison and nearby counties, in the Elk Mountains around Gothic and in Maroon Bells/Snowmass Wilderness areas; and in San Juan and Hinsdale counties. However, it has also been collected east of the divide in Chaffee County. Due to its diminutive form and remote location, it may have been overlooked elsewhere. *Packera porteri* flowers from mid-July to mid-August.

Packera pseudaurea (Greene) var. **flavula** D.K. Trock & T.M. Barkley, Phytologia. 49:48. 1981. *Senecio pseudaureus* var. *flavulus* (Greene) Greenm.; *Senecio flavulus* Greene.

Perennials. **Caudices** simple or branched, fibrous-rooted, horizontal to erect. **Stems** 2–5+ dm, thin and slender, single or occasionally 2–4 clustered, glabrous or lightly tomentose proximally. **Leaves**: basal leaves petiolate, blades broadly

lanceolate to ovate or occasionally sub-hastate, 2–4+ × 2–3+ cm, bases truncate to subcordate or obtuse, margins bluntly dentate or denticulate, rarely sharply toothed; lower cauline leaves petiolate, blades sublyrate to lacinate or occasionally subentire; middle and upper cauline leaves progressively reduced distally, becoming sessile, occasionally clasping. **Heads** radiate, 5–12+ heads in a congested cyme. Peduncles inconspicuously bracteolate, glabrous. **Calyculi** present. **Phyllaries** 21 or occasionally 13, rarely 30 or more, light green, 3–6 mm, glabrous. **Ray florets** 8 or 13, corolla laminae 6–10+ mm, or occasionally absent. **Disc florets** 60–80+, corolla tubes 3.5–4.5 mm, limbs 2–3 mm. **Cypselae** 1–1.5 mm long, glabrous, pappi 4.5–5.5 mm long. 2n = 46

This variety of *P. pseudaurea* is found in the southern Rocky Mountains and is most abundant in Colorado. It inhabits the same habitat type as *P. paupercula*, and its gross morphology is similar. The comments following the description of *P. paupercula* provide a suite of six characteristics that can be used to distinguish the two entities. *Packera pseudaurea* var. *flavula* flowers from late May to early July. Where the two occur at similar elevations and in similar habitats, *P. pseudaurea* var. *flavula* usually flowers about one month earlier than *P. paupercula*.

Packera streptanthifolia (Greene) W.A. Weber & Löve var. **streptanthifolia**
Phytologia. 49:48. 1981. *Senecio streptanthifolius* Greene; *Senecio cymbalarioides* var. *streptanthifolius* (Greene) Greenm.

Senecio cymbalarioides Nutt.; *Senecio streptanthifolia* var. *laetiflorus* (Greene) J.F. Bain; *Senecio streptanthifolius* var. *rubricaulis* (Greene) J.F. Bain; *Senecio cognatus* Greene; *Senecio wardii* Greene; *Senecio adamsi* Howell; *Senecio suksdorfii* Greenm.; *Senecio longipetiolatus* Rydb.; *Senecio fulgens* Rydb.; *Senecio rydbergii* A. Nelson; *Senecio jonesii* Rydb.; *Senecio subcuneatus* Rydb.; *Senecio platylobus* Rydb.; *Senecio streptanthifolius* var. *oodes* (Rydb.) J.F. Bain; *Senecio oodes* Rydb.; *Senecio leonardii* Rydb.; *Senecio streptanthifolius* var. *kluanei* J.F. Bain; *Senecio streptanthifolius* var. *wallowensis* J.F. Bain.

Perennials. **Caudices** weak to stout, fibrous-rooted, horizontal to suberect. **Stems** 2–4+ dm, single or 2–5 clustered, glabrous or occasionally lightly floccose tomentose proximally and in leaf axils. **Leaves:** basal and lower cauline leaves, petiolate, thick and turgid, blades varying from oblanceolate or ovate to orbicular, 2–4+ × 1–3+ cm, bases tapering or abruptly contracted, margins entire, crenate, dentate or weakly lobulate, normally glabrous or sometimes persistently pubescent; middle and upper cauline leaves gradually reduced distally, becoming sessile, margins entire to sub-entire. **Heads** radiate, 6–15+ in loose corymbiform or subumbellate arrays. Peduncles variably bracteolate, glabrous or lightly tomentose. **Calyculi** present and conspicuous. **Phyllaries** 13 or 21, occasionally 8, green or with anthocyanic tips, 4–7+ mm, glabrous. **Ray florets** 8 or 13, corolla laminae 5–10 mm. **Disc florets** 35–60+, corolla tubes 2–4 mm, limbs 2.5–4 mm. **Cypselae** 1–2.5 mm long, glabrous, pappi, 3–6 mm long. 2n = 46.

Packera streptanthifolia grows in a wide variety of habitats, from forested

areas to open meadows and valleys and in soils ranging from dry and rocky to damp and loamy. It also occurs at a wide range of elevations, from 6500 feet to above timberline. The species is complex and has been divided by some researchers (Bain 1983, 1988) into as many as seven distinct taxa—five species and two varieties or two species and five varieties. This author recognizes only one species and two varieties, while acknowledging that there is a great amount of morphological variation. There is less morphological variation within this species in Colorado than there is in other parts of its range.

The narrow-leaved phase of *P. streptanthifolia* could superficially be confused with *P. neomexicana* var. *mutabilis*. However, the former has glabrous achenes, while achenes of the latter are normally hirtellous. *Packera streptanthifolia* in Colorado normally has leaves that are ovate to orbicular. Probably the most reliable characteristics are the thick and turgid leaf blades, and a very stout fibrous-rooted caudex. In Colorado, this species flowers from early June to early July at lower elevations and from mid-July to mid-August at high elevations.

Packera tridenticulata (Rydb.) W.A. Weber & Löve, Phytologia. 49:48. 1981. *Senecio tridenticulatus* Rydb.

Senecio compactus Rydb.; *Senecio densus* Greene; *Senecio oblanceolatus* Rydb.; *Senecio acutidens* Rydb.; *Senecio manitobensis* Greenm.; *Senecio remifolius* Wooton & Standley.

Perennials. **Caudices** taprooted, ascending to erect. **Stems** 1–3+ dm, single or frequently several clustered, glabrous or rarely lightly floccose-tomentose, often with tufts of tomentum in leaf axils. **Leaves:** basal and lower cauline leaves petiolate, blades thick and turgid, lanceolate or narrowly oblanceolate, 2–4+ × 0.5–1.5 cm, bases tapering, margins entire, subentire or dentate at the apex, occasionally sub-pinnatisect; middle and upper cauline leaves gradually or progressively reduced distally, becoming sessile. **Heads** radiate, 4–15+ heads in corymbiform arrays. Penduncles bracteolate, glabrous to lightly tomentose. **Calyculi** numerous but small. **Phyllaries** 13–21, green, 6–10 mm, sparsely tomentose proximally, glabrous distally. **Ray florets** 8–10 or occasionally 13, corolla laminae 5–8+ mm. **Disc florets**, 45–60+, corolla tubes 3–3.5 mm, limbs 4–5 mm. **Cypselae** 1.5–2.5 mm long, glabrous or lightly hirtellous on the angles, pappi 5–6 mm long. 2n = 46.

This species can be found in shortgrass prairies or sagebrush scrub habitats, growing in dry gravelly or sandy soils. It is primarily a plant of the central High Plains, but its range extends into the foothills of the Rockies and into some of the high valleys west of the Rocky Mountain Front in Colorado. It tends to grow in clumps with several stems arising from a single taprooted, woody caudex. The only other species in Colorado with which it may be confused is *P. neomexicana* var. *mutabilis*. That relationship is discussed in detail under *P. neomexicana*. *Packera tridenticulata* flowers from late May to early July.

Packera werneriifolia (A. Gray) W.A. Weber & Löve, Phytologia 49:48. 1981. *Senecio werneriaefolius* A. Gray.

Senecio saxosus Klatt; *Senecio petrocallis* Greene; *Senecio scaposus* A. Nelson; *Senecio perennans* A. Nelson; *Senecio muirii* Greenm.; *Senecio molinarius* Greenm.

Perennials. **Caudices** branching, sub-rhizomatous, sometimes several densely crowded and caespitose. **Stems** 7–15+ cm, single or 3–5 clustered, floccose or lanate-tomentose, canescent or occasionally glabrate. **Basal Leaves** sessile or with very short petioles, blades narrowly lanceolate to elliptic, 1.5–4+ × 0.5–2.5 cm, bases tapering, margins entire or dentate toward the apex, frequently revolute; or in some populations petiolate with blades ovate to orbicular, 1–2 × 0.5–1.5 cm, bases tapering to abruptly contracted, margins entire or wavy, occasionally dentate toward the apex. **Cauline leaves** reduced to mere bracts, plant with a scapose aspect. **Heads** radiate, 1–5 or in some populations 3–8. Peduncles inconspicuously bracteolate, glabrous to densely pubescent. **Calyculi** conspicuous, frequently anthocyanic. **Phyllaries** 13 or 21, green or with anthocyanic apices, 4–10 mm, glabrous to pubescent. **Ray florets** 8 or 13, corolla laminae 5–10 mm; or occasionally absent. **Disc florets** 30–50+, corolla tubes 2.5–3.5 mm, limbs 3–4 mm. **Cypselae** 1.5–2 mm long, glabrous, pappi 5–6 mm long. 2n = 44 or 46.

This species grows on rocky talus slopes or in sandy soil in forest openings near or above timberline. Flowering time varies greatly with elevation but is generally from mid-June to mid-August. Some specimens have basal leaf blades that are sessile and very narrow, while the basal leaves of others are petiolate and more ovate in outline. Some specimens are densely tomentose, while others are only lightly pubescent, even glabrate. But the feature that all of the specimens have in common is their scapose aspect.

The only species in Colorado with which it could be confused is *P. cana*, and that relationship is discussed in detail under the comments for *P. cana*.

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BOOK NOTICES

ELIZABETH SILVERTHORNE. 2002. **Legends and Lore of Texas Wildflowers.** (ISBN 1-58544-230, pbk.). Texas A&M University Press, John H. Lindsey Bldg., Lewis St. 4354 TAMU, College Station, TX 77843-4354, U.S.A. (Orders: wlawrence@tamu.edu, http://www.tamu.edu/upress, 800-826-8911). $24.95 hbk., $16.95 pbk., 264 pp., 18 line drawings, Bib. Index, 7" × 9".

Forty-four Texas wildflowers are discussed in this book. Their botanical names as well as their common names are given, and stories about the origins and lore surrounding them are the focus. This is not a field guide or identification book, but rather a collection of interesting tales about these particular flowers.

The author does deal with the habitats, descriptions, uses—medicinal and otherwise—of the plants, and tells something of the early botanists. In fact it is crammed with information told in non-technical terms. Some of the flowers are illustrated, although the artist is not credited. It is a pleasant addition to the literature of wildflowers.—*Ruth Ginsburg, Botanical Research Institute of Texas, Fort Worth, TX, U.S.A.*

ROY L. LEHMAN, RUTH O'BRIEN, and TAMMY WHITE. 2002. **Plants of Webb County, Texas.** (ISBN not given, pbk.). Texas A&M University-Corpus Christi, Dept. of Physical and Life Sciences, 6300 Ocean Drive, Corpus Christi, TX 78412, U.S.A. (Orders: 512-994-2754, fax 512-994-2742). Price not given, 47 pp., numerous color photos, 1 map, index, 5 1/2" × 8 1/2".

According to the foreword, "This booklet was first designed to be a guide for secondary school, college students and for the laymen interested in flowers and plants found on the Galvan Ranch." It was decided that, as the ranch was no longer accessible to the general public, that the guide be reformatted and titled to include common and interesting plants from the county [Webb]."

Each of the species covered in the book includes a color photograph, common name(s), Latin name and some synonyms, followed by a brief description including habitat and flowering time. The authors are to be congratulated for all the hard work on this book. It is especially nice because of the lack of floras for that part of Texas. A big thank you goes to the Ed Rachel Foundation in Corpus Christi for their financial support of the project. The Foundation's support of research on Texas native plants is truly appreciated; what an incredible gift to the people of Webb County and Texas.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

NOMENCLATURAL COMBINATIONS IN NORTH AMERICAN *PANICUM* SUBGENUS *DICHANTHELIUM* AND SUBGENUS *AGROSTOIDES* (POACEAE: PANICEAE)

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ABSTRACT

The new combinations made here are: *Panicum aciculare* var. *ramosum*; *Panicum aciculare* var. *neuranthum*; *Panicum acuminatum* var. *ferventicola*; *Panicum acuminatum* var. *thermale*; *Panicum commutatum* var. *equilaterale*; *Panicum ovale* var. *praecocius*; and *Panicum rigidulum* var. *abscissum*.

RESUMEN

Se hacen las siguientes nuevas combinaciones: *Panicum aciculare* var. *ramosum*; *Panicum aciculare* var. *neuranthum*; *Panicum acuminatum* var. *ferventicola*; *Panicum acuminatum* var. *thermale*; *Panicum commutatum* var. *equilaterale*; *Panicum ovale* var. *praecocius*; y *Panicum rigidulum* var. *abscissum*.

The debate over whether *Dichanthelium* should be recognized as a segregate genus from *Panicum* or as a subgenus of *Panicum* will probably never be resolved, with both 'camps' having data to support their views. It is a debate that I will not get into here, but will only provide references for both treatments, so the reader can form their own opinion. Gould (1974), Clark and Gould (1975), Gould and Clark (1978), Gould (1980) and Giussani et. al (2001) support the recognition of *Dichanthelium* as a segregate genus. Whereas, Pohl (1980), Lelong (1984), Zuloaga (1987), Morrone and Zuloaga (1991), Zuloaga et al. (1991) and Zuloaga et al. (1993) support the recognition of *Dichanthelium* as a subgenus of *Panicum*; a classification with which I also agree.

Freckmann and Lelong (2002) published fifty-two new combinations in *Dichanthelium* and *Panicum* while preparing their treatment for Volume 25 of *The Flora of North America* (Barkworth et al. [eds.], in press). Some of the taxa treated in *Dichanthelium* by Freckmann and Lelong (2002) do not have an available name in *Panicum*, which are required for use in the *Vascular Plants of Texas: A Comprehensive Checklist including Synonymy, Bibliography, and Index* (Jones et al. 1997), revision in progress, as well as, for on going work on *Panicum* subg. *Dichanthelium* in North America. In addition, *Panicum abscissum* Swallen is recognized at the rank of variety and not subspecies, following the treatment of *Panicum rigidulum* by Lelong (1984), since no data were presented in Freckmann

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and Lelong (2002) warranting the treatment of these taxa at the subspecific rank.

Panicum aciculare Desvaux ex Poiret var. **ramosum** (Griseb.) Wipff, comb nov.
BASIONYM: *Panicum neuranthum* Griseb. var. *ramosum* Griseb., Cat. pl. Cub. 232. 1866. *Panicum fusiforme* Hitchc., Contr. U.S. Natl. Herb. 12:222. 1909. *Dichanthelium fusiforme* (Hitchc.) Harvill, Castanea 42:177. 1977. *Dichanthelium aciculare* var. *ramosum* (Griseb.) Davidse, Novon 2:104. 1992. *Dichanthelium aciculare* Desvaux ex Poiret subsp. *fusiforme* (Hitchc.) Freckmann & Lelong, Sida 20:167. 2002. TYPE: CUBA: western Cuba, 1863, *C. Wright 3454* (HOLOTYPE : GOET, fragment US).

Panicum aciculare Desvaux ex Poiret var. **neuranthum** (Griseb.) Wipff, comb et stat. nov. BASIONYM: *Panicum neuranthum* Griseb., Cat. pl. Cub. 232. 1866. *Dichanthelium aciculare* Desvaux ex Poiret subsp. *neuranthum* (Griseb.) Freckmann & Lelong, Sida 20:167. 2002. TYPE: CUBA: eastern Cuba, 1860, *C. Wright 3453* (HOLOTYPE : US).

Panicum acuminatum Sw. var. **ferventicola** (Schmoll) Wipff, comb. et stat. nov.
BASIONYM. *Panicum ferventicola* Schmoll, Madroño 5:92. 1939; and the autonym created by *Panicum ferventicola* var. *papillosum* Schmoll, Madroño 5:94 and *Panicum ferventicola* Schmoll var. *sericeum* Schmoll, Madroño 5:92. 1939. TYPE: U.S.A. WYOMING: Yellowstone National Park, in fine gravel in warm soil close to a boiling spring, bathed in hot vapor, 5 mi N of Norris Geyser Basin, 10 Aug 1908, *A. Chase 5252* (HOLOTYPE: GH).

Panicum ferventicola Schmoll var. *sericeum* Schmoll, Madroño 5:92. 1939. *Dichanthelium lanuginosum* (Elliott) F.W. Gould var. *sericeum* (Schmoll) Spellenberg, Madroño 23:150. 1975. *Dichanthelium acuminatum* (Swartz) F.W. Gould & C.A. Clark var. *sericeum* (Schmoll) Freckmann, Phytologia 48:107. 1981. *Dichanthelium acuminatum* (Swartz) F.W. Gould & C.A. Clark subsp. *sericeum* (Schmoll) Freckmann & Lelong, Sida 20:168. 2002. TYPE: U.S.A. WYOMING: in wet ground about hot springs, Mammoth Hot Springs, Yellowstone National Park, 21 Jul 1889, *A. Nelson & E. Nelson 6037* (HOLOTYPE: RM 20108).

Panicum ferventicola Schmoll var. *papillosum* Schmoll, Madroño 5:94. 1939. TYPE: CANADA. ALBERTA: Banff, on declivity wet with water from hot spring, 31 Jul 1914, *A.S. Hitchcock 11511* (HOLOTYPE: GH).

Panicum acuminatum Sw. var. **thermale** (Bol.) Wipff, comb. nov. BASIONYM: *Panicum thermale* Bol., Proc. Calif. Acad. Sci. 2:181. 1862. *Dichanthelium lanuginosum* (Elliott) F.W. Gould var. *thermale* (Bol.) Spellenberg, Madroño 23:151. 1975. *Dichanthelium acuminatum* (Swartz) F.W. Gould & C.A. Clark var. *thermale* (Bol.) Freckmann, Phytologia 48:107. 1981. *Dichanthelium acuminatum* (Swartz) F.W. Gould & C.A. Clark subsp. *thermale* (Bol.) Freckmann & Lelong, Sida 20:168. 2002. TYPE: U.S.A. CALIFORNIA: northern part of Sonoma County, on hot rocks and in hot water flowing from Geyser Springs and Geyser Mountains, *H.N. Bolander 3941* (HOLOTYPE: GH).

Panicum commutatum Schultes var. **equilaterale** (Scribner) Wipff, comb. et stat. nov. BASIONYM: *Panicum equilaterale* Scribner, Bull. Div. Agrostol. U.S.D.A. 11:42. 1898. *Dichanthelium commutatum* (Schultes) Gould subsp. *equilaterale* (Scribner) Freckmann & Lelong, Sida 20:169. 2002. TYPE: U.S.A. FLORIDA: Lake Co.: scrubby hammock lands, Eustis, 16–25 Aug 1894, *G.V. Nash 1674* [LECTOTYPE: US 743929 (designated by Hitchc. & Chase, Contr. U.S. Natl. Herb. 15:310. 1910)].

Panicum ovale Elliott var. **praecocius** (Hitchcock & Chase) Wipff, comb. nov.
BASIONYM: *Panicum praecocius* Hitchc. & Chase, Rhodora 8:206. 1906. *Panicum lanuginosum* Elliott var. *praecocius* (Hitchc. & Chase) Dore in McNeill & Dore, Naturaliste Canad. 103:562. 1977. *Dichanthelium villosissimum* (Nash) R.W. Freckman var. *praecocius* (Hitchc. & Chase)

Freckmann, Phytologia 39:270. 1978. *Dichanthelium ovale* (Elliott) F.W. Gould & C.A. Clark subsp. *praecocius* (Hitchc. & Chase) Freckmann & Lelong, Sida 20:170. 2002. TYPE: U.S.A. ILLINOIS: Stark Co.: dry bank, near Wady Petra, 30 Jun 1900, *V.H. Chase 649* (HOLOTYPE: US 558686).

Panicum rigidulum Nees var. **abscissum** (Swallen) Wipff, stat. nov. BASIONYM: *Panicum abscissum* Swallen, J. Wash. Acad. Sci. 30:215, f. 4. 1940. *Panicum rigidulum* Bosc ex Nees subsp. *abscissum* (Swallen) Freckmann & Lelong, Sida 20:172. 2002. TYPE: U.S.A. FLORIDA: Sebring, in dry sand at tourist camp near lake, 3 Oct 1925, *P. Weatherwax s.n.* (HOLOTYPE: US 1259952).

ACKNOWLEDGMENTS

I am grateful to K.N. Gandhi (GH) for his insightful review and comments regarding the nomenclature. I also would like to thank S.D. Jones (BRCH) and two anonymous reviewers for their helpful suggestions and comments on the manuscript.

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Zuloaga, F.O., J. Dubcovsky, and O. Morrone. 1991. Infrageneric phenetic relations in New World *Panicum* (Poaceae: Panicoideae: Paniceae): a numerical analysis. Canad. J. Bot. 71:1312–1327.

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PERFORATION PLATE DIVERSITY IN *ILLICIUM FLORIDANUM* (ILLICIACEAE) WITH RESPECT TO ORGANS, PROVENANCE, AND MICROTECHNICAL METHODS

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ABSTRACT

Pit membrane remnants in scalariform perforations of mature *Illicium floridanum* vessels of stems and roots from three sources were studied with scanning electron microscope (SEM). Several methods of preservation and microtechnical treatment were used; results for all of these methods, for the three sources, and for the two organs revealed similar patterns. The perforation pit membranes illustrated are believed to be relatively free of artifacts. Pit membrane presence in perforations of all collections of *I. floridanum* studied ranges from intact non-porose pit membranes to near absence of any pit membrane fragments. However, the extreme conditions are relatively infrequent, and the most common condition is presence of less than 50% of the pit membrane; presence of more than 50% of the pit membrane is somewhat less common. The phylogenetic significance of pit membrane presence in perforations is considered a symplesiomorphic feature for angiosperms. Presence of pit membrane remnants in perforations is valuable in phylogenetic analyses of angiosperms.

KEY WORDS: basal angiosperms, Illiciales, perforation plates, pit membrane remnants, tracheid-vessel transition, vessel evolution, wood evolution.

RESUMEN

Se estudiaron al microscopio electrónico de barrido (SEM) restos de las membranas de punteaduras de las perforaciones escalariformes de vasos de tallos y raíces de *Illicium floridanum* maduros procedentes de tres fuentes. Se usaron varios métodos de conservación y tratamientos microtécnicos; obteniendo patrones similares con todos los métodos, para las tres fuentes y los dos órganos. Las perforaciones de las membranas de las punteaduras que se ilustran se cree que no tienen artefactos. La presencia de punteaduras de membrana en las perforaciones de todas las colecciones de *I. floridanum* estudiadas varían desde punteaduras intactas no-porosas hasta la casi ausencia de fragmentos de membrana. Sin embargo, las condiciones extremas son relativamente infrecuentes, y las condiciones más comunes son la presencia de menos del 50% de membrana de la punteadura; la presencia de más del 50% de la membrana de la punteadura es algo menos frecuente. El significado filogenético de la presencia de la membrana de la punteadura en las perforaciones se considera una característica simplesiomorfica en angiospermas. La presencia de restos de la membrana de la punteadura en las perforaciones es valiosa en los análisis filogenéticos en angiospermas.

INTRODUCTION

Presence of pit membrane remnants in perforations of primitive woody dicotyledons with scalariform perforation plates was figured by Meylan & Butterfield (1978) for several species of New Zealand woods, such as *Ascarina lucida* Hook.f., *Carpodetus serratus* J.R. & G. Forst., *Quintinia acutifolia* Kirk, and *Weinmannia*

racemosa L.f. Similar figures were presented by Takahashi (e.g., 1985). Meylan and Butterfield (1978) refer to threadlike pit membrane remnants as "microfibrillar webs," and in some cases this describes the appearances well. In others (*Ascarina*, *Weinmannia*), the pit membranes look essentially intact; they contain circular pores of various sizes. Pit membrane remnants in a simple perforation plate of *Knightia* (Proteaceae) were figured by Butterfield and Meylan (1982).

In a review of this phenomenon (Carlquist 1992a), the term "pit membrane remnants" was proposed to describe the diversity of pit membranes or membrane portions that occur as threads as well as those that occur as persistent sheets in which component microfibrils are not evident. Pit membrane remnants occur in a number of dicotyledon families (Carlquist 1992a) as well as in some monocotyledons (see illustrations and literature cited in Carlquist & Schneider 1997, 1998; Schneider & Carlquist 1998) and ferns (Carlquist & Schneider 2001 and literature cited therein).

Pit membrane remnants appear characteristic of particular families, such as Chloranthaceae (Carlquist 1990, 1992b, 1992c). Among the families that currently constitute Illiciales, pit membrane remnants are most conspicuous in *Illicium* (Carlquist 1992b; Carlquist & Schneider 2002b), sole genus of Illiciaceae, as well as in the monospecific family Austrobaileyaceae (Carlquist 2001) and both genera of Schisandraceae (Carlquist 1999). The survey of the genus *Illicium* with respect to pit membrane remnants (Carlquist 1992a) showed diversity but not the causes for this diversity. Conceivably, the sources for different degrees and types of pit membrane remnant presence in *Illicium* can be related to differences among species, differences in provenance, differences among parts of a single plant, or differences in methods of preparation. The present paper has selected one readily available species, *Illicium floridanum* Ellis, because pit membrane remnants in perforations appeared abundant and varied on the basis of preliminary observations (Carlquist 1992a), and because material of living plants is readily available.

An understanding of the diversity of pit membrane remnants in *Illicium floridanum* is needed as a baseline against which to compare diversity in such remnants in other dicotyledons. Do pit membrane remnants indicate a primitive character state in phylads of angiosperms as suggested by Carlquist (1992a)? Can degrees of pit membrane presence be indicative of departure from tracheid-like tracheary elements, and if so, can these degrees be used cladistically and can they help us understand the nature of the tracheid-vessel element transition (Carlquist & Schneider, in press)?

MATERIAL AND METHODS

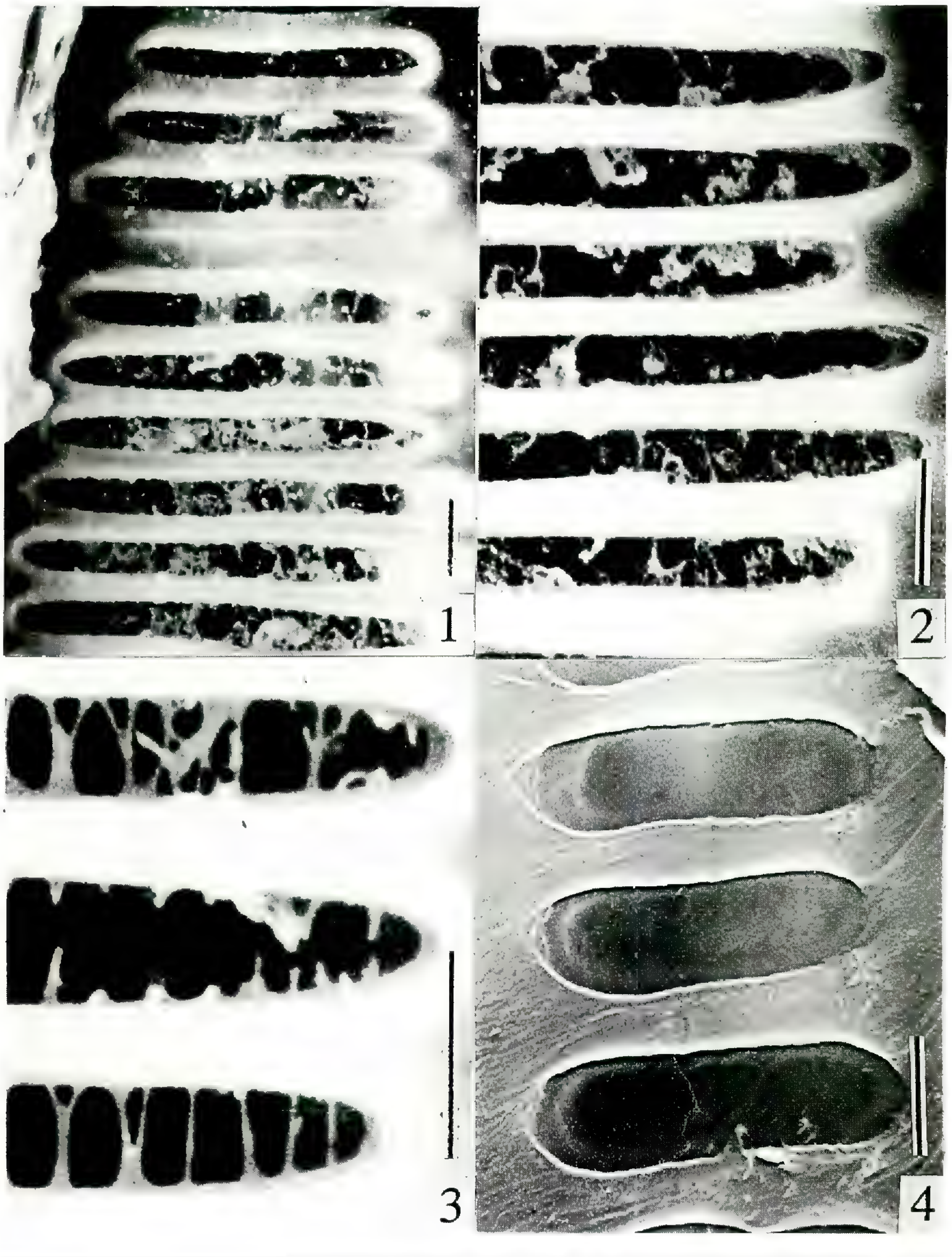
The dried *Illicium floridanum* stem (Palmer 19768; "Florida" without further locality) was derived from a specimen 12 mm in transectional diameter in the

RSAw collection. This specimen had been donated to Rancho Santa Ana Botanic Garden by the U.S. National wood collection (USw). A portion of this specimen was boiled in water, stored in 50% aqueous ethanol, and sectioned on a sliding microtome. Some of the sections were dried between clean glass slides, sputter coated with gold and examined with an ISI WB-6 scanning electron microscope (SEM) at Rancho Santa Ana Botanic Garden. Living stems (8 mm in diameter) of the species were obtained from a cultivated plant in the lathhouse at University of California, Santa Barbara, and were preserved in 50% aqueous ethanol. A stem 5 mm in diameter was obtained from the University of Florida, Gainesville. Living roots of the species (10 mm in diameter) were provided by the U.S. National Arboretum, Washington, D.C., and were preserved in 50% aqueous ethanol. Root and stem portions from living specimens were preserved in alcohol without the use of any other reagents in order to minimize artifact formation in the pit membranes of perforation plates. Critical-point drying was not employed because in mature woods, many vessels are already filled with air and critical-point drying would be redundant (Butterfield & Meylan 1982). The stems and roots derived from living specimens were sectioned on a sliding microtome (only radial sections were prepared). Sections were dried between glass slides, sputter-coated with gold, and observed with a Bausch & Lomb Nanolab 200 SEM at Santa Barbara Botanic Garden. Thick sections (ca. 50 μm) were cut in order to obtain complete sheets extending from cambium to pith rather than fragmentary sections. Thick sections offer no disadvantage where SEM is involved. Thick sections, on the contrary, are more likely than thin sections to have long portions of perforation plates or even entire perforation plates.

Low accelerating voltage was applied to the SEM-observed sections whenever possible in order to minimize the possibility of beam damage to the pit membranes. We believe that tearing of pit membranes from sources other than sectioning (the effects of which can easily be detected) was negligible. Our results seem comparable to the photograph of pit membranes for *Weinmannia racemosa* (Meylan & Butterfield 1978). Current literature on wood anatomy does not consider these appearances to be instances of artifact formation. In order to stress the nature of pit membrane remnants, our illustrations are at high magnifications. Our equipment does not offer maximal resolution compared to newer machinery, unfortunately. Also, the nature of SEM involves lowered retrieval of electrons from depressed areas such as perforations, and thus resolution is less than for convex structures.

RESULTS

Perforation plates in *Illicium floridanum* (e.g., Fig. 1) are scalariform and are easily distinguished from lateral wall pitting, which consists of pits with relatively short length, separated from each other by bands of wall material appreciably wider than the bars of a perforation plate. Pit membranes of pits on lat-



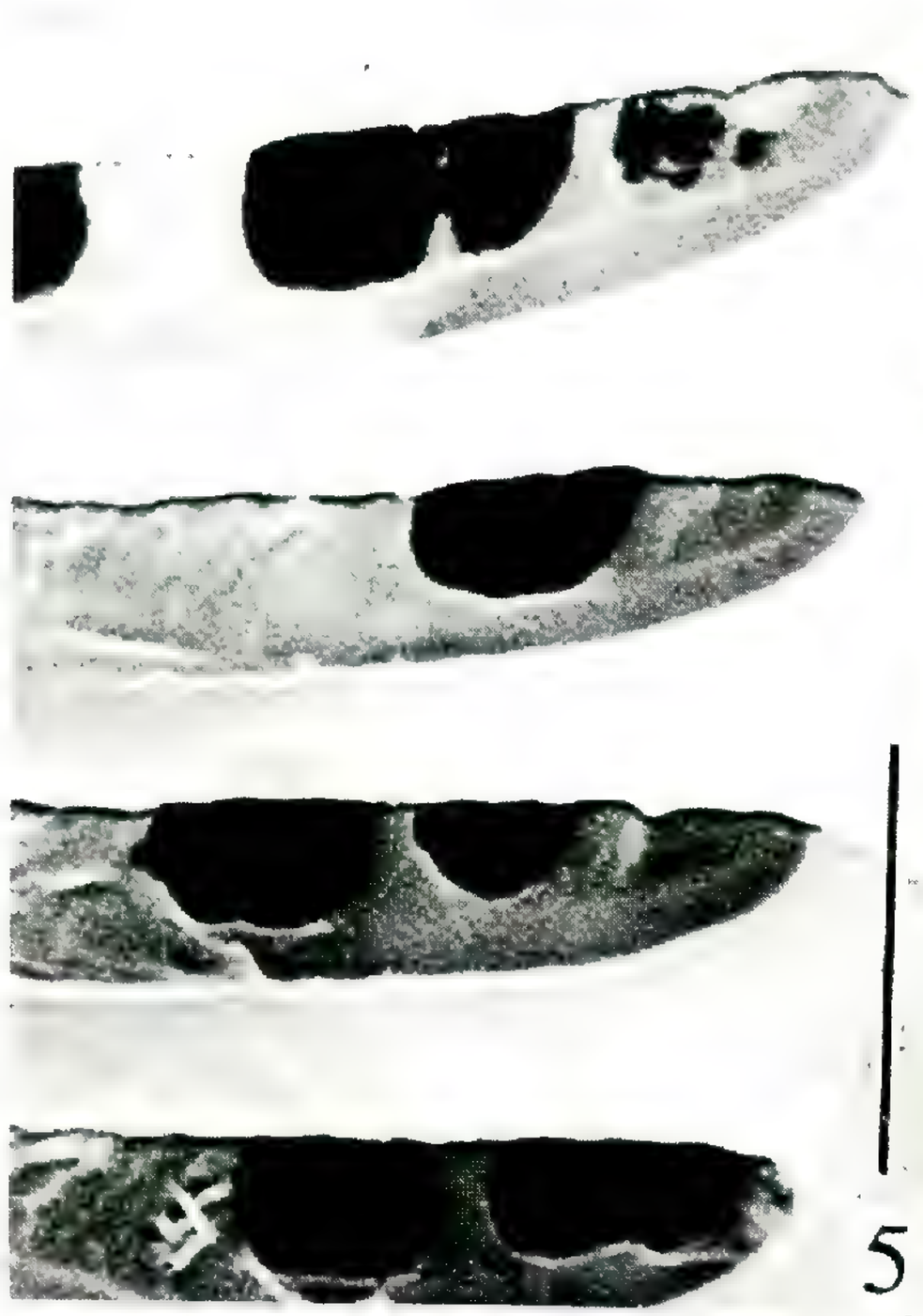
FIGS. 1–4. SEM photographs of radial sections of *Illicium floridanum* vessels. Figs. 1–3. Portions of perforation plates from dried stem wood sample. **Fig. 1.** About a quarter of a perforation plate, pit membrane remnants visible in the perforations. **Fig. 2.** Perforations similar to those of Fig. 1, showing weblike pit membrane remnants. **Fig. 3.** Perforations containing strandlike pit membrane remnants; breakage of threads in the central perforations is interpreted as an artifact created by drying of wood sample or sectioning. **Fig. 4.** Pits on lateral wall of vessels, showing absence of any pores in pit membranes. Magnification scale in each figure = 5 µm.

eral walls of vessel elements were intact and devoid of any pores (Fig. 4); nearly all of the pit membranes in perforations have pores in a sheetlike membrane, or threadlike or strandlike remnants of a pit membrane (Figs. 1–3, 5–11). We have presented a photograph of an exceptional pit membrane from a perforation plate in which pit membranes that lack visible pores or holes were retained (Fig. 12); such non-porose perforation pit membranes were infrequent, present in fewer than 5% of the perforation plates we examined, with the exception of the uppermost (or lowermost) perforation in some perforation plates. One or two such terminal perforations, which may be considered transitional to lateral wall pitting, may be seen in numerous perforation plates, but no such non-porose perforations occur in the remainder of most perforation plates. Our comments, unless otherwise stated, refer to perforation plates only, and describe conditions other than the exceptional type of perforation pit membranes illustrated in Figure 12.

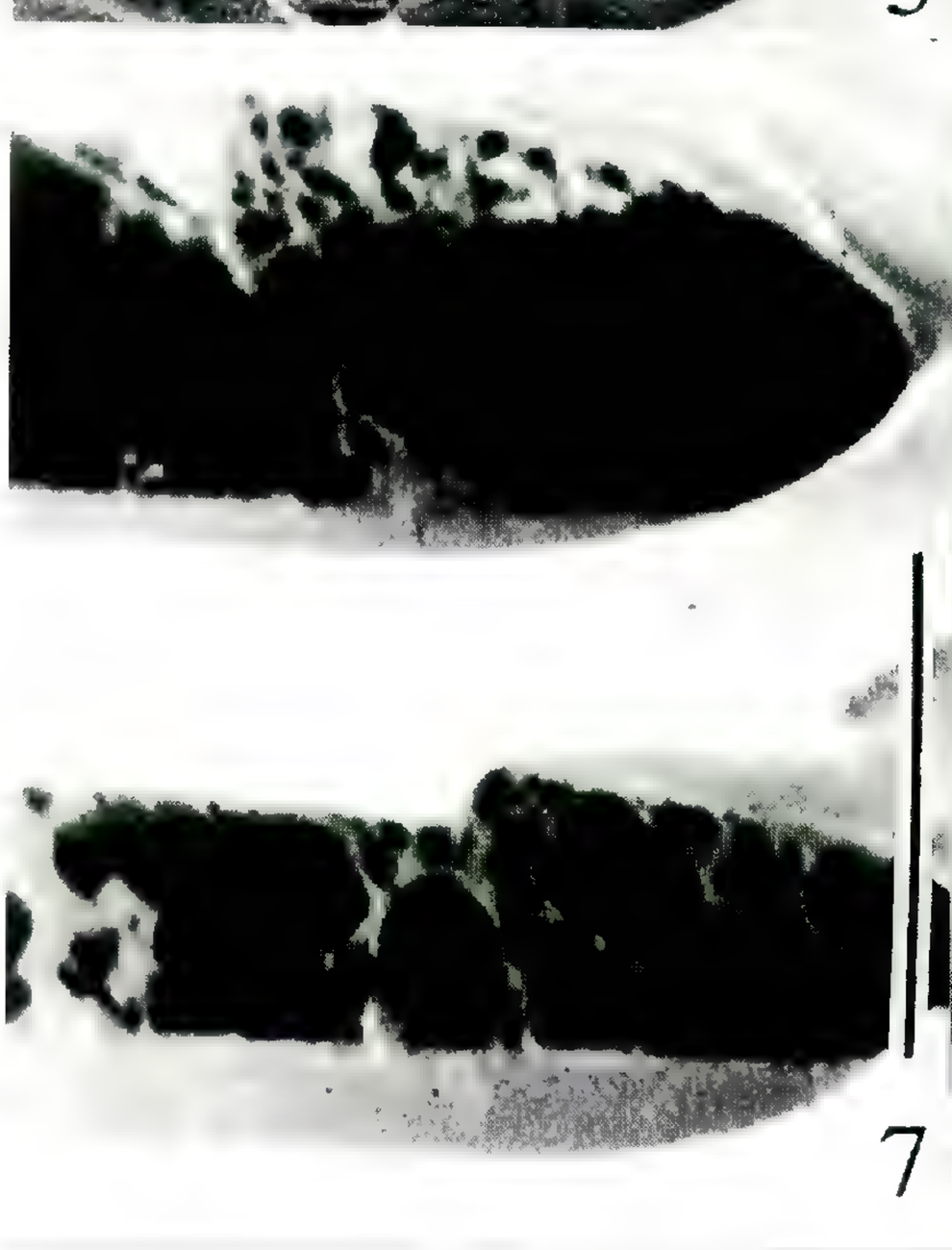
Pit membrane remnants are retained in perforations of the dried wood sample that was boiled in water prior to sectioning (Fig. 1–3). The durability of these membranes is attested by retention of seemingly delicate weblike membrane portions (Figs. 1, 2). Also preserved by this method are strandlike pit membrane remnants that run parallel to the long axis of the vessel element (Fig. 3).

Study of wood from living specimens of stems fixed in 50% ethanol reveals a wide range of pit membrane remnants in perforations (Figs. 5–8). Circular to oval holes in pit membranes characterize numerous perforation plates (Fig. 5). This type of pit membrane may coexist in a perforation plate with pit membranes in the form of strands (Fig. 6). Some pit membranes in the form of weblike remnants can be found (Fig. 7). Above in Figure 7 is a pit membrane fragment containing pores; this illustrates the transition between porose sheets of pit membranes and weblike pit membranes. In Figure 8, pit membrane remnants are restricted to the ends of perforations. The remnants shown contain small pores of various sizes and shapes. The perforations shown in Figure 8 are, because of restriction of pit membranes to ends of perforations, mostly clear. Perforations with small vestiges of pit membranes of this sort, but with most perforation area clear of membrane remnants, characterized about 10% of the perforation plates in this material. Also present in the liquid-preserved stems from living plants were a few perforation plates in which pit membranes were intact, like those shown in Figure 12. Such intact pit membranes are not from immature vessel elements, since they can occur at various points between pith and cambium.

Liquid-preserved roots from living cultivated plants also revealed a wide range of pit membrane conditions (Figs. 9–12). In Figure 9, portions of two perforation pit membranes are illustrated. As suggested by the irregular distribution of pores and holes, pit membranes in this perforation plate possessed some

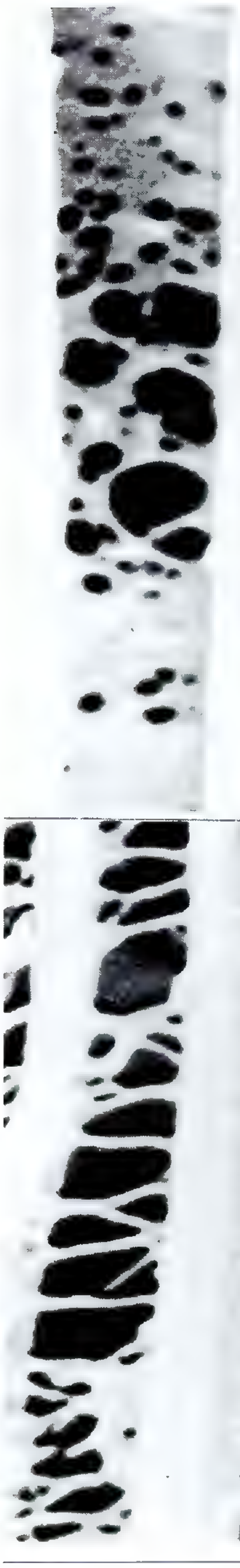




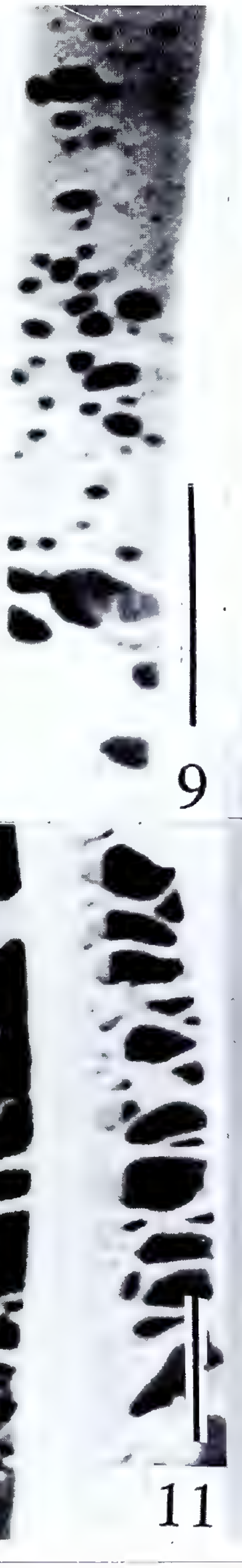




FIGS. 5–8. SEM photographs of perforation plate portions from radial sections of stem wood sample of *Illicium floridanum* (plant cultivated at University of California, Santa Barbara). **Fig. 5.** Perforations with oval holes in pit membranes (upper portion of holes obscured by oblique view of perforations). **Fig. 6.** Perforations with pit membranes containing holes and with some strands (upper portions of some holes obscured by oblique view of perforations). **Fig. 7.** Perforations with weblike pit membranes and (top) small pores in a pit membrane portion. **Fig. 8.** Perforations clear except for porose remnants at the ends of the perforations. Magnification scale in each figure = 5 μm.



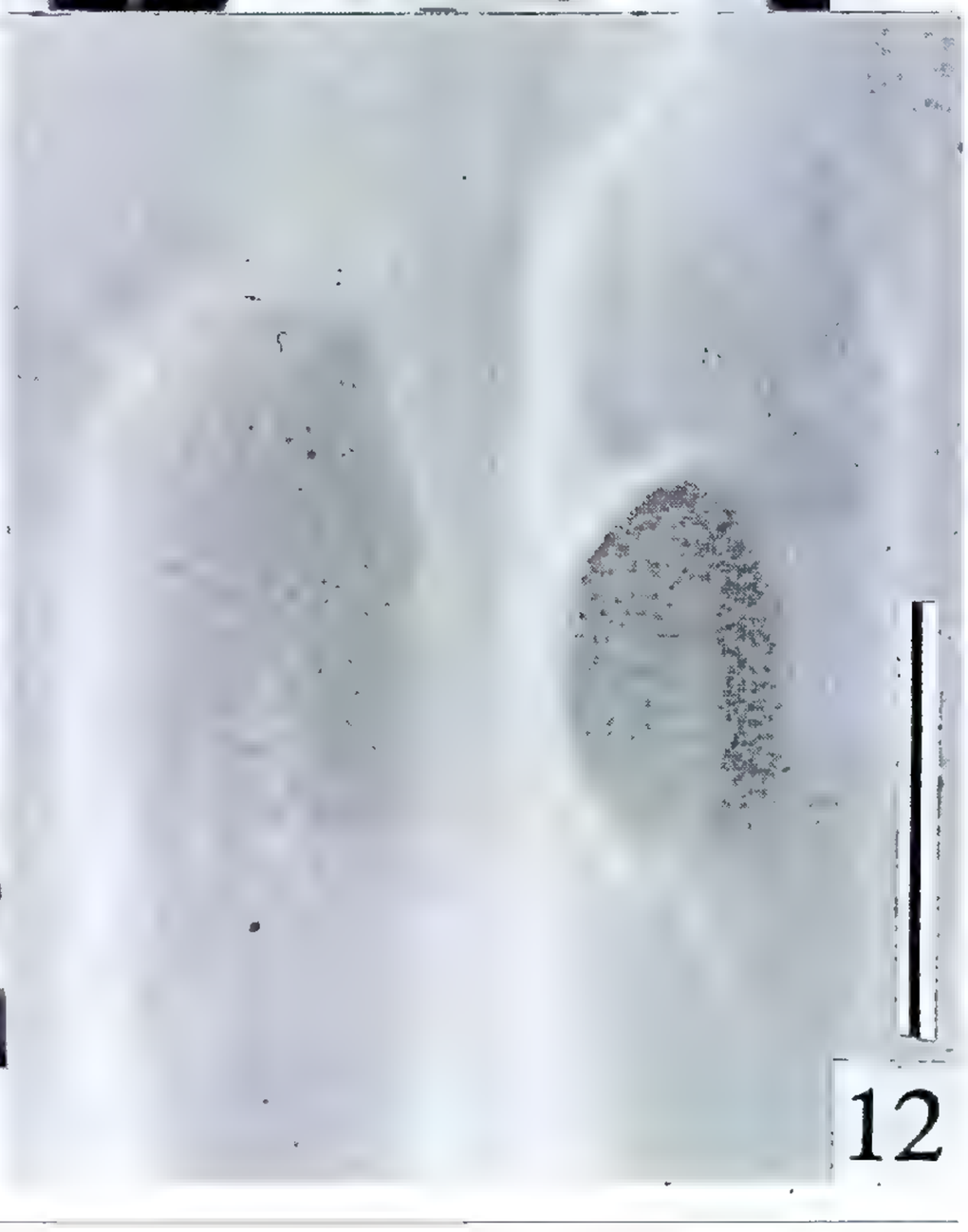
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10



11



12

FIGS. 9–12. SEM photographs of perforation portions (long axes of perforations (or pits) arranged vertically) from radial sections of wood from root of *Illicium floridanum* cultivated at the U.S. National Arboretum. **Fig. 9.** Pit membranes that have non-porose portions as well as circular to oval pores of various sizes. **Fig. 10.** Pit membranes that have some circular to oval holes; other portions of pit membranes are in the form of strands traversing the perforation. **Fig. 11.** Pit membranes that are almost entirely in the form of strands. **Fig. 12.** Portion of perforation plate illustrating intact pit membranes, lacking any visible pores. Magnification scales in each figure = 5 µm.

areas apparently devoid of pores, whereas others had small pores and others larger holes. A further stage in development of open areas within the pit membrane remnants is represented in Figure 10. The areas apparently devoid of holes in Figure 10 may result from inhibition of lysis, perhaps by adherence of some overlying substance, a possibility observed in *Ascarina* (Carlquist 1990). In Figure 11, however, minimal inhibition of lysis is evident, and almost all of the pit membrane remnants are in the form of delicate strands. Portions of an uncommon type of perforation in which hydrolysis producing pores did not occur are illustrated in Figure 12. As mentioned in the preceding paragraph, this type of perforation plate is probably not immature, because perforation plates with intact pit membranes can occur at any point between the cambium and the pith. A few perforation plates with minimal pit membrane remnants were also observed in the root material.

DISCUSSION AND CONCLUSIONS

Before examining the significance of the various manifestations of pit membrane presence in perforations, the issue of possible artifact formation must be addressed. Certainly tears due to sectioning or handling do occur, but rips in pit membranes attributable to damage can easily be identified by their contours, and are not mentioned in the above descriptions. The appearances we describe are believed to represent naturally-occurring conditions. The living stem and root portions were subjected only to dilute alcohol. The entirely intact nature of lateral wall pits of vessels in these materials serves as a control, certifying that application of this single reagent does not create artifacts. Dilute ethanol has never, to our knowledge, been claimed to create pores or holes in pit membranes.

We did observe that prolonged exposure of perforation pit membranes at high magnification and moderate to high accelerating voltage resulted in tearing. This tearing, like that due to processing, is easily identifiable, in our opinion. The pit membranes in perforations of *Illicium floridanum* seemed to resist deformation by the electron beam better than perforation pit membranes of other dicotyledons we have studied, notably *Amborella* (Carlquist & Schneider 2001b).

A source of pit membrane destruction in perforations that is difficult to estimate is the potential action of the conduction stream. One might attribute distortions like tears to pit membranes altered by the conductive stream or by formation of air embolisms.

Assuming that the appearances illustrated in the present paper are relatively free from artifacts, how can one interpret the phenomenon of pit membrane remnants in perforation plates? The distribution of dicotyledons with pit membrane remnants in perforations (Carlquist 1992a) suggests that this is a relictual feature, as though vessel elements were not definitively differentiated.

The listing given in Carlquist (1992a), if compared to recent phylogenies, such as that of Soltis et al. (2000), shows that pit membrane remnants are more common in the families of basal angiosperms, as well as in lower branches of eudicot clades and monocotyledons (Carlquist & Schneider 1998; Schneider & Carlquist 1998) on the basis of admittedly incomplete data. Many additional instances of pit membrane presence in perforations in dicotyledons have yet to be reported. However, the rarity of pit membrane remnants in the woods sampled by Meylan and Butterfield (1978) is likely indicative of the frequency of this phenomenon if a large sampling of dicotyledons were to be surveyed.

Pit membrane dissolution in perforations is presumably an easily achieved process, involving the action of enzymes. However, we do not know whether this process can be phylogenetically reversed or not. Quite conceivably, a few instances of pit membrane retention in perforations might be achieved secondarily. The occurrence of pit membranes in perforations of some *Myrothamnus* vessels might be such an instance (Carlquist 1988). However, restoration of pit membrane remnants phylogenetically seems likely to be infrequent, an occurrence only in woods with scalariform perforation plates. Once a simple perforation plate has been achieved, retention of portions of a pit membrane in the perforation plate seems unlikely, and indeed, apparently no cases of pit membrane remnants in simple perforation plates have been reported.

Degrees of pit membrane presence in perforations have been cited as indicating character state changes (Carlquist & Schneider 2002a. Five character states are designated in that paper (0 = pit membrane with no visible porosities; 1 = pit membrane with small porosities; 2 = pit membrane with less than 50% perforated; 3 = pit membrane present, but with more than 50% absent; 4 = pit membrane absent or essentially so. All stem and root wood sections of *Illicium floridanum* represented here cover the complete gamut from 0 to 4, inclusive. However, character states 0 and 4 are relatively infrequent, and could be neglected if one were constructing a data matrix for this species. The majority of perforation plates in *I. floridanum* would fall into character state 3, with character state 2 less common. We see no problem in designating the most common character state for a specimen of a particular species, even if other character states coexist with the most common manifestation. End wall angles of vessel elements and number of bars per perforation plate are features with wide ranges of expression within a single wood sample, yet they are frequently cited (often in the form of means) as indicators of degree of phylogenetic specialization.

ACKNOWLEDGMENTS

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BOOK NOTICES

RICHARD SPELLENBERG. 2003. **Sonoran Desert Wildflowers.** (ISBN 0-7627-1136-1, pbk.). The Globe Pequot Press, 246 Goose Lane, PO Box 480, Guilford, CT 06437, U.S.A. (Orders: 800 826-8911, fax 800-820-2329). $24.95 pbk., 246 pp., numerous color photos, 7 b/w figures, 1 map, 1 graph, 7" × 9".

From the back cover: *Sonoran Wildflowers* is the ultimate field guide to wildflowers of North America's most biologically diverse desert, which straddles the Gulf of California between the Baja Peninsula and northwestern Sonora and stretches north into California and Arizona. Packed with vivid color photos and informative text, this valuable reference will help you identify and appreciate the varied flora of this vast region's six different climates." The author's photographs are exceptionally crisp and vibrant. Botanists and wildflower enthusiasts alike cannot go wrong with having this book in their library.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

ELIZABETH A. (BERNDT) GEORGE, watercolour paintings and illustrations by MARGARET PIERONI. 2002. **Verticordia: The Turner of Hearts.** (ISBN 1-876268-46-8, hbk.). University of Western Australia Press (www.uwapress.uwa.edu.au), Crawley, Western Australia 6009 in association with Australian Biological Resources Study, GPO Box 787, Canberra, Australian Capital Territory 2601. (Orders: International Specialized Book Services, 5824 NW Hassalo St., Portland, OR 97213-3644, U.S.A.; 503-287-3093, fax 503-280-8832, www.isbs.com, email: info@isbs.com). $84.95 hbk., 422 pp., 102 plates of watercolor paintings with line drawings, maps, 8 1/4" × 11 14".

From the back cover: "*Verticordia: The Turner of Hearts* brings together for the first time available information on all the described taxa of *Verticordia* (101 species, 13 subspecies and 30 varieties) providing a comprehensive, user-friendly guide to their identification and cultivation." *Verticordia* is a member of the Myrtaceae family. Each species comes with a description followed by information on the distribution, habitat, flowering period, distinguishing characteristics, other names used (synonyms), cultivation, and conservation status. A key to infrageneric taxa and species is provided.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

COMPARISON OF THE MORPHOLOGY, FLOWERING PHENOLOGY, AND LIFE CYCLE TYPE IN PLANTS OF *GRINDELIA LANCEOLATA* (ASTERACEAE) FROM CEDAR GLADES IN MIDDLE TENNESSEE AND NORTHERN ALABAMA: A COMMON GARDEN STUDY

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ABSTRACT

The life cycle type of *Grindelia lanceolata* Nutt. has been described as biennial, short-lived monocarpic perennial, and (polycarpic) perennial in the taxonomic literature. Plants of this species in middle Tennessee cedar glades clearly are monocarpic. However, field observations suggested that those from glades in northern Alabama are at least dicarpic, and further that they differ morphologically and flower later than those in Tennessee glades. The purpose of this study was to determine if differences in morphology, flowering phenology, and/or life cycle type of Tennessee and Alabama plants are retained when grown from seeds in a "common garden" - i.e., in a nonheated greenhouse in Lexington, Kentucky. Morphological differences (all statistically significant) between *G. lanceolata* plants from Tennessee and Alabama were measure in the following: (1) size of both rosette and stem leaves; (2) number of secondary basal stems; (3) height of primary stem; (4) number of capitula per plant; (5) number of ray and of disk flowers per capitulum; (6) diameter of capitulum; and (7) length of ray flower corolla . Tennessee plants began flowering about 1 month earlier than Alabama plants, and none of them produced basal rosettes after they flowered once (in their 2nd year), confirming that they are strictly monocarpic. Alabama plants also flowered first in their 2nd year; however, 66% of them have produced basal rosettes (which bolted and flowered) for five consecutive growing seasons, confirming that they are polycarpic. Also, individual Tennessee plants potentially can produce twice as many seeds as individual Alabama plants during a single flowering/fruiting period. These results strongly suggest genetic differences exist in vegetative and floral morphology, flowering phenology, and life cycle type between Tennessee and Alabama plants of *G. lanceolata*. We speculate that these differences could be associated with different ancestral geographic origins: Tennessee plants from a monocarpic race in the Ozarks and Alabama plants from a perennial race in the Southwest.

RESUMEN

El tipo de ciclo de vida de *Grindelia lanceolata* Nutt. ha sido descrito, en la literature taxonómica, como bianual, como perenne monocárpico de vida corta y como perenne (policárpico). Las plantas

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de esta especie presentes en claros calcáreos del área central de Tennessee son claramente monocárpicas. Sin embargo, observaciones de campo sugieren que aquellas de la zona norte de Alabama son, al menos, dicárpicas; y mas allá, que difieren morfológicamente y que florecen más tarde que aquellas de los claros calcáreos de Tennesssee. El propósito de este estudio fue determinar si las diferencias en morfología, fenología floral y/o tipo de ciclo de vida de plantas de Tennessee y Alabama se mantienen cuando las plantas crecen a partir se semillas en un "jardin comun" - i.e., en un vivero sin calefacción en Lexington, Kentucky. Las diferencias morfológicas (todas estadísticamente significativas) entre plantas de *G. lanceolata* de Tennessee y de Alabama incluyen: (1) el tamaño de ambas clases de hojas, de roseta y de tallos; (2) número de tallos basales secundarios; (3) altura del tallo principal; (4) número de capítulos por planta; (5) número de flores radiales y de disco por capítulo; (6) diámetro del capítulo; y (7) longitud de la corolla de las flores radiales. Las plantas de Tennessee comenzaron a florecer aproximadamente 1 mes más temprano que las plantas de Alabama y ninguna de ellas produjo rosetas basales después de haber florecido una vez (en su 2do año), confirmando que son monocárpicas estrictas. Las plantas de Alabama también florecieron en su 2do año; sin embargo, 66% de ellas siguió produciendo rosetas basales (que desarrollaron tallo y florecieron) por cinco períodos de crecimiento, confirmando que son policárpicas. Además, cada individuo de Tennessee puede producir potencialmente el doble se semillas que los individuos de Alabama durante cada período de floración/fructificación. Los resultados sugieren claramente que hay diferencias genéticas en la morfología vegetativa y floral, la fenología floral, y los tipos de ciclo de vida entre plantas de *G. lanceolata* de Tennessee y de Alabama. Especulamos que estas diferencias pueden deberse a que estos dos grupos tengan diferentes orígenes geográficos: las plantas de Tennessee, de una raza monocárpica en los Ozarks; y las plantas de Alabama, de razas perennes del sudoeste.

INTRODUCTION

Grindelia lanceolata Nutt. (Asteraceae) is an herbaceous species that grows in open habitats on shallow soils underlain by limestone (Steyermark 1934, 1937; Baskin and Baskin 1979). Its geographical range extends from the Ozarks of Missouri and southeastern Kansas, south through eastern Oklahoma and northern and western Arkansas, and into northeastern and central Texas (Steyermark 1934, 1999; Correll and Johnston 1970; GPFA 1986; Smith 1988; Nesom 1990). Nesom (1990) also reports the species from the Monterrey area in Nuevo Leon, Mexico. Disjunct populations occur in the Central Basin of Tennessee (Chester et al. 1997) and in northern Alabama (Small 1933; Harper 1944), where they are associated closely with open cedar glades (Baskin & Baskin 1979, 1996; Baskin et al. 1995). *Grindelia lanceolata* has been reported from Louisiana (Rydberg 1932; Small 1933); however, Gandhi and Thomas (1989) do not list the species in their recent treatment of the Asteraceae of Louisiana. The species also has been reported from a single county in southeastern Ohio (Jones 1943; Fisher 1988), where, apparently, it has been introduced (Porter 1956).

In his taxonomic treatment of Texas species of *Grindelia*, Nesom (1990) recognized three varieties of *G. lanceolata*: *lanceolata*, *texana* (Scheele) Shinners, and *greenei* (Steyermark) Nesom, the latter known only from Mexico. However, Correll and Johnston (1970) did not recognize any separate taxonomic entities and thus included only *G. lanceolata* in their treatment. Julian A. Steyermark listed two forms of *G. lanceolata* in his Flora of Missouri (1999): *lanceolata* and

latifolia Steyerm., the latter known from only one county in Missouri. Small (1933), Fernald (1950), Gleason (1963), GPFA (1986), Gleason and Cronquist (1991), and Chester et al. (1997) do not recognize any intraspecific taxa in *G. lanceolata*.

With regard to life cycle type, *G. lanceolata* has been reported to be biennial (Rydberg 1932), short-lived monocarpic perennial (Baskin & Baskin 1979; GPFA 1986; Gleason & Cronquist 1991), and (presumably polycarpic) perennial (Small 1933; Correll and Johnston 1970; Enquist 1987; Nesom 1990). In their study on the autecology and population biology of *G. lanceolata* in the limestone cedar glades of the Central Basin of Tennessee, Baskin and Baskin (1979) found that plants were short-lived monocarpic perennials (i.e., plants lived for a few years before they bolted and flowered once, and then died). The youngest plants to flower in the Baskins' study were in their third growing season (2+ years old). Other plants in the study flowered in their fourth or fifth year; all plants died after flowering once (i.e., monocarpic).

However, during field studies in the limestone cedar glades in northern Alabama, Baskin and Baskin (pers. obs.) noticed that Alabama plants of *G. lanceolata* differed in morphology, flowering time, and life cycle type. In contrast to plants in Tennessee, rosettes were present on those with dead flowering stalks in Alabama, suggesting that this species is at least dicarpic in the cedar glades of northern Alabama. The purpose of this study was to determine if there are distinct measurable or observable differences in vegetative morphology, floral morphology, flowering phenology, and/or life cycle type between *G. lanceolata* plants from Tennessee and Alabama cedar glades. To determine if differences in morphology and life cycle type are genetically—or environmentally—based, both Tennessee and Alabama plants were grown from seed in a common environment, i.e., a common garden experiment.

MATERIALS AND METHODS

Growth Conditions

All plants used in this study were grown from seeds in a nonheated greenhouse in Lexington, KY. Seeds were collected in autumn 1996 from *G. lanceolata* populations growing in cedar glades in Tennessee and Alabama and sown (separately) on soil in metal flats. The greenhouse soil mix was a 3:1 (v/v) mixture of limestone-derived topsoil and river sand. Following germination, juveniles were transplanted to 15-cm-diameter plastic pots in spring 1997 and assigned a number. Morphological and life cycle features of 103 Alabama plants and of 88 Tennessee plants were monitored in this study; plants of both groups were numbered consecutively.

Temperatures in the nonheated greenhouse were recorded continuously with an electric thermograph for the duration of the five-year study period. From these recordings, mean daily maximum and minimum temperatures for

TABLE 1. Five-year mean monthly maximum (± SE) and minimum (± SE) temperatures (°C) to which *Grindelia lanceolata* plants were exposed during the study.

Month	Maximum	Minimum
January	6.95 ± 1.4	1.71 ± 0.38
February	10.95 ± 0.88	4.00 ± 0.72
March	14.48 ± 1.40	5.65 ± 1.10
April	21.92 ± 1.30	11.81 ± 0.64
May	28.6 ± 0.77	18.22 ± 0.79
June	30.62 ± 0.46	20.9 ± 0.49
July	32.13 ± 1.20	23.15 ± 0.85
August	31.68 ± 0.92	22.05 ± 0.71
September	28.18 ± 0.95	17.75 ± 0.99
October	20.05 ± 0.35	12.6 ± 0.68
November	15.6 ± 1.10	8.23 ± 1.00
December	8.5 ± 1.40	3.03 ± 0.60

each month for each of the five years were determined. These temperatures then were used to calculate mean maximum (± SE) and minimum (±SE) monthly temperatures (°C) for the study (Table 1). Average daily photosynthetic photon irradiance at plant level in the nonheated greenhouse, measured with a LI-COR model LI-1000 data logger and three LI-190-SA quantum sensors, ranged from 6 mol m^{-2} d^{-1} on overcast days to 25 mol m^{-2} d^{-1} on clear days during the growing season (March to October) (Snyder et al. 1994).

Vegetative and Floral Morphology

To determine if there are differences in vegetative morphology, various leaf characters were compared between the two groups of plants. Length, width, oven-dry mass, and specific leaf area were determined for leaves collected from the rosette and from the lower-, middle-, and upper (just below the terminal capitulum) portions of the main stem. One leaf each from these four regions of the shoot was removed and measured/weighed for every plant in the study. Leaf length and width were measured to the nearest mm using a standard metric ruler. The width measurement was taken at the widest part of the leaf. Leaves were dried in an oven at 70°C for 24 hours, and their dry mass determined with an analytical balance. Average values for each leaf character were calculated for all plants in the study. Leaf prints were made using Diazo-type paper for ammonia developing, and leaf area (one side of leaf) was determined by weight of paper/area print relationships. Specific leaf area (SLA) was calculated using the following equation: $SLA = A_{leaf}/W_{leaf}$ where A_{leaf} is leaf area (one side only) and W_{leaf} is leaf dry weight. SLA was determined for one leaf from each of the four shoot levels for each plant in the study, and then average values were calculated for leaves of each position. In addition, number of secondary basal stems

and height of each plant were determined and averages calculated. All means were compared by t-tests (P=0.05).

Number of capitula for the main stem and for all secondary stems were counted and averages calculated for each plant in the study. Floral measurements were made on 15 Tennessee plants and on 15 Alabama plants selected randomly using a random-numbers table. Number of ray and disk flowers, length and width of ray flower corolla, and diameter were measured, to the nearest mm, for the terminal capitulum of the main stem of each of the 30 plants. The terminal capitulum is always the first to flower on a plant. Capitulum diameter and corolla length and width were measured using a standard metric ruler and means calculated. All means were compared by t-tests (P=0.05).

Flowering Phenology

The terminal capitula of the main stems were monitored for flowering. The flowering period in this study extended from the beginning of flowering (indicated by the first anther of the first disk flower to shed pollen; ray flowers are pistillate) in the first plant and ended with the beginning of flowering in the last plant. Beginning of pollen shed was determined by brushing a finger across the anthers and observing if clumps of the bright yellow pollen adhered to it.

Seed Production Potential

To assess the reproductive effort of *G. lanceolata*, potential number of seeds per individual plant was calculated. Potential number of seeds per individual for Alabama and for Tennessee plants was calculated as follows: Potential number of seeds produced per plant = (Avg. no. capitula per main stem x Avg. no. ray flowers per capitulum) + (Avg. no. capitula per main stem x Avg. no. disk flowers per capitulum) + (Avg. no. capitula per secondary stem x Avg. no. secondary stems x Avg. no. ray flowers per capitulum) + (Avg. no. capitula per secondary stem x Avg. no. secondary stems x Avg. no. disk flowers per capitulum).

RESULTS

Vegetative and Floral Morphology

Length, width, dry weight, and SLA of leaves from the rosette, and from the lower-, middle-, and upper portions of the main stem, differed significantly between Tennessee and Alabama plants of *G. lanceolata* (Table 2). Only rosette dry weight and length of leaves on the lower portion of the stem were nonsignificant. In general, plants from Alabama had longer, wider, and heavier leaves, a higher SLA, and were taller than Tennessee plants. However, Tennessee plants produced significantly more secondary stems than Alabama plants (Table 2).

Tennessee plants produced significantly more capitula per plant on both main stems and secondary, basal stems than did Alabama plants (Table 3). Average number of capitula per main stem and per secondary stem was significantly higher for Tennessee plants. Alabama plants produced larger capitula

TABLE 2. Comparison (mean ± SE) of several vegetative and floral morphological characteristics of *Grindelia lanceolata* plants from Tennessee and Alabama. An asterisk indicates means for a character are significantly different (t test, P = 0.05), whereas NS indicates that they are not significantly different at this level.

Character	Tennessee	Signif. Level	Alabama
Rosette Leaf			
Length (cm)	8.6 ± 0.2	*	7.3 ± 0.2
Width (cm)	0.7 ± 0.01	*	0.9 ± 0.02
Weight (g)	0.038 ± 0.006	NS	0.045 ± 0.003
SLA (cm^2/g)	159.81 ± 11	*	211.37 ± 14
Lower Leaf			
Length (cm)	9.3 ± 0.1	NS	9.6 ± 0.2
Width (cm)	0.7 ± 0.2	*	1.2 ± 0.3
Weight (g)	0.039 ± 0.007	*	0.063 ± 0.006
SLA (cm^2/g)	173.53 ± 15	*	200.97 ± 1
Middle Leaf			
Length (cm)	7.8 ± 0.2	*	8.9 ± 0.2
Width (cm)	0.6 ± 0.01	*	1.3 ± 0.02
Weight (g)	0.031 ± 0.005	*	0.070 ± 0.002
SLA (cm^2/g)	115.84 ± 7	*	147.46 ± 14
Upper Leaf			
Length (cm)	6.3 ± 0.1	*	7.0 ± 0.2
Width (cm)	0.5 ± 0.02	*	1.0 ± 0.03
Weight (g)	0.0396 ± 0.002	*	0.057 ± 0.004
SLA (cm^2/g)	125.63 ± 5	*	135.86 ± 10
No. Secondary Stems	3.1 ± 0.2	*	1.4 ± 0.1
Height (cm)	55.39 ± 0.2	*	86.09 ± 0.2
Ray Flower Petals			
Length (cm)	1.45 ± 0.1	*	2.05 ± 0.3
Width (cm)	0.33 ± 0.06	NS	0.30 ± 0.04

(i.e., greater diameter) and more ray flowers per capitulum than did Tennessee plants. Number of disk flowers, however, did not differ significantly between the two groups. Ray flowers from Alabama plants had longer petals than Tennessee plants, but there was no difference in petal width between the two groups.

Flowering Phenology

All plants from both groups bolted and flowered in their second year. Flowering in Tennessee plants began on 1 July 1998, and all terminal flowers of main stems had flowered by 5 August 1998 (Fig. 1). In contrast, flowering in Alabama plants began and ended on 26 July and 7 September, respectively. For both groups, capitula elsewhere on the main stem and on secondary stems continued to

TABLE 3. Comparison of number of capitula and of ray and disk flowers produced by *Grindelia lanceolata* plants from Tennessee and Alabama. All values are expressed as means (± SE) except for total number of capitula produced by all plants. An asterisk indicates means of each character are significantly different (t test, P = 0.05), whereas NS indicates that they are not significantly different at this level.

Character	Tennessee	Signif. Level	Alabama
Total No. Capitula Produced			
Main Stem	629		408
Secondary Stems	271		53
No. Capitula Produced			
Main Stem	7.3 ± 3	*	4.0 ± 1
Secondary Stems	2.2 ± 0.5	*	1.1 ± 0.3
No. Ray Flowers	22 ± 4	*	31 ± 3
No. Disk Flowers	203 ± 34	NS	252 ± 71
Capitulum Diameter (cm)	4.4 ± 0.2	*	5.7 ± 0.5

flower 1–2 weeks following the beginning of anthesis of the last terminal main stem capitulum.

After completion of flowering, all Tennessee plants (n=88) died; not a single one produced a new basal rosette. However, many Alabama plants continued to produce new rosettes and to bolt and flower over the course of the five-year study period (Figs. 1, 2). One-hundred and three Alabama plants bolted and flowered in 1998, 78 in 1999, 74 in 2000, 73 in 2001, and 68 in 2002 (Fig. 2). Flowering period duration was 43 days in 1998, 48 in 1999, 43 in 2000, 39 in 2001, and 44 in 2002 (Fig. 1). Length of flowering period in 1998 was 36 days for Tennessee plants (Fig. 1). Flowering (both terminal and all other capitula) for both groups had been completed by mid-September.

Seed Production Potential

An individual Tennessee plant had the potential to produce an average of 3,128 seeds, while a single Alabama plant had the potential to produce only 1,568 seeds.

DISCUSSION

Observations by Baskin and Baskin that Alabama *G. lanceolata* plants appeared to be distinct in morphology, flowering time, and life cycle type from those in Tennessee were supported by the results of this study. Alabama plants are taller and have larger leaves than Tennessee plants. One of the more striking differences between the two groups is the number of secondary basal stems. Tennessee plants produce more than two times as many secondary basal stems as do Alabama plants, giving them a suffrutescent-like appearance. Indeed, Tennessee

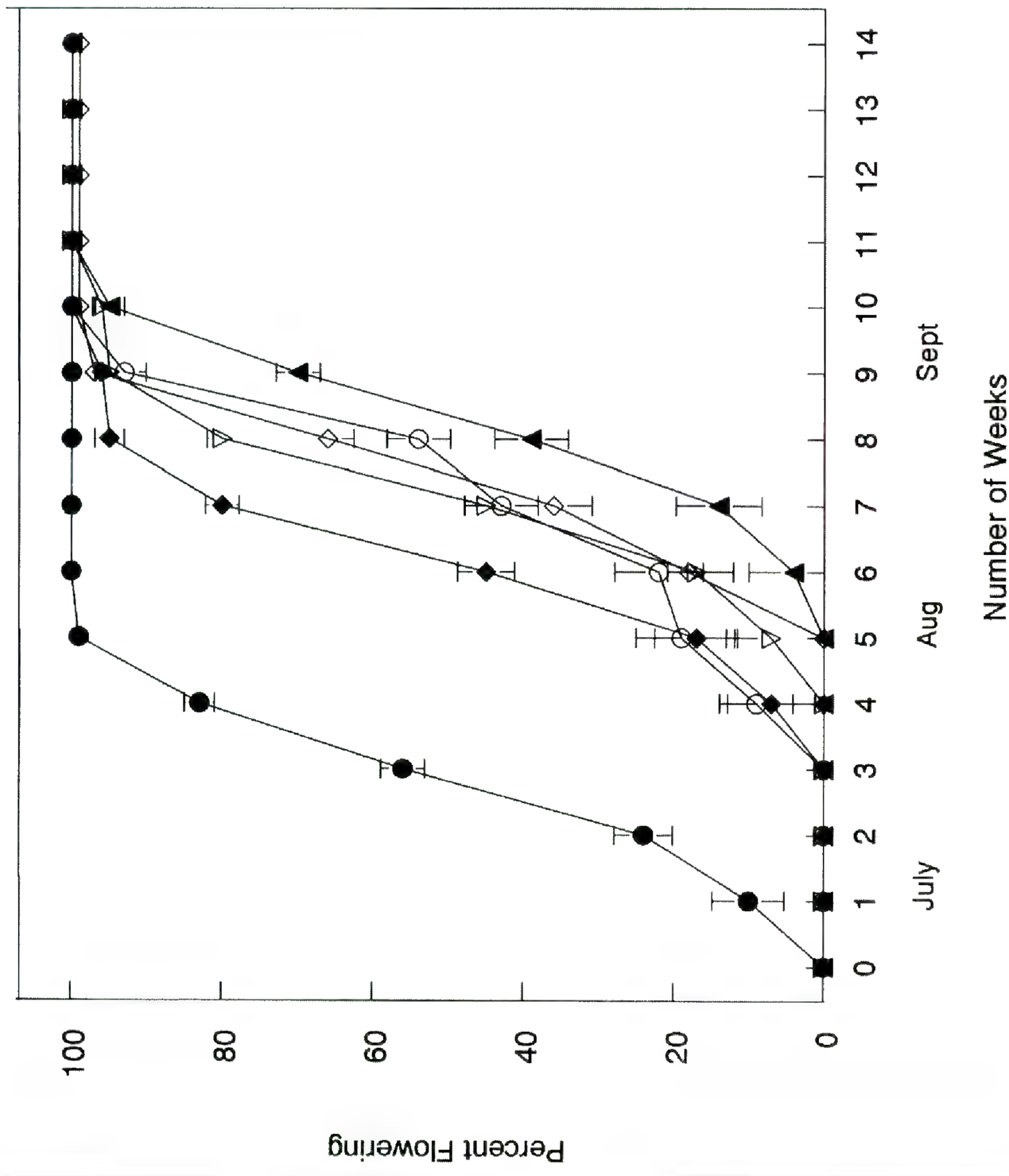


Fig. 1. Flowering phenology for 88 Tennessee *Grindelia lanceolata* plants in 1998 (●) and for 103 *Grindelia lanceolata* Alabama plants in 1998 (◆), 1999 (◇), 2000 ( ), 2001 (▲), and 2002 (○).

and Alabama plants can be distinguished easily on the basis of height and branching pattern.

Average diameter of the terminal capitulum of Alabama plants is greater, by more than 1 cm, than that of Tennessee plants. Compared to Tennessee plants, terminal capitula of Alabama plants produce significantly more ray flowers and longer ray petals. On the other hand, Tennessee plants produce twice as many capitula per secondary stem and nearly twice as many (1.85:1) per main stem as do Alabama plants.

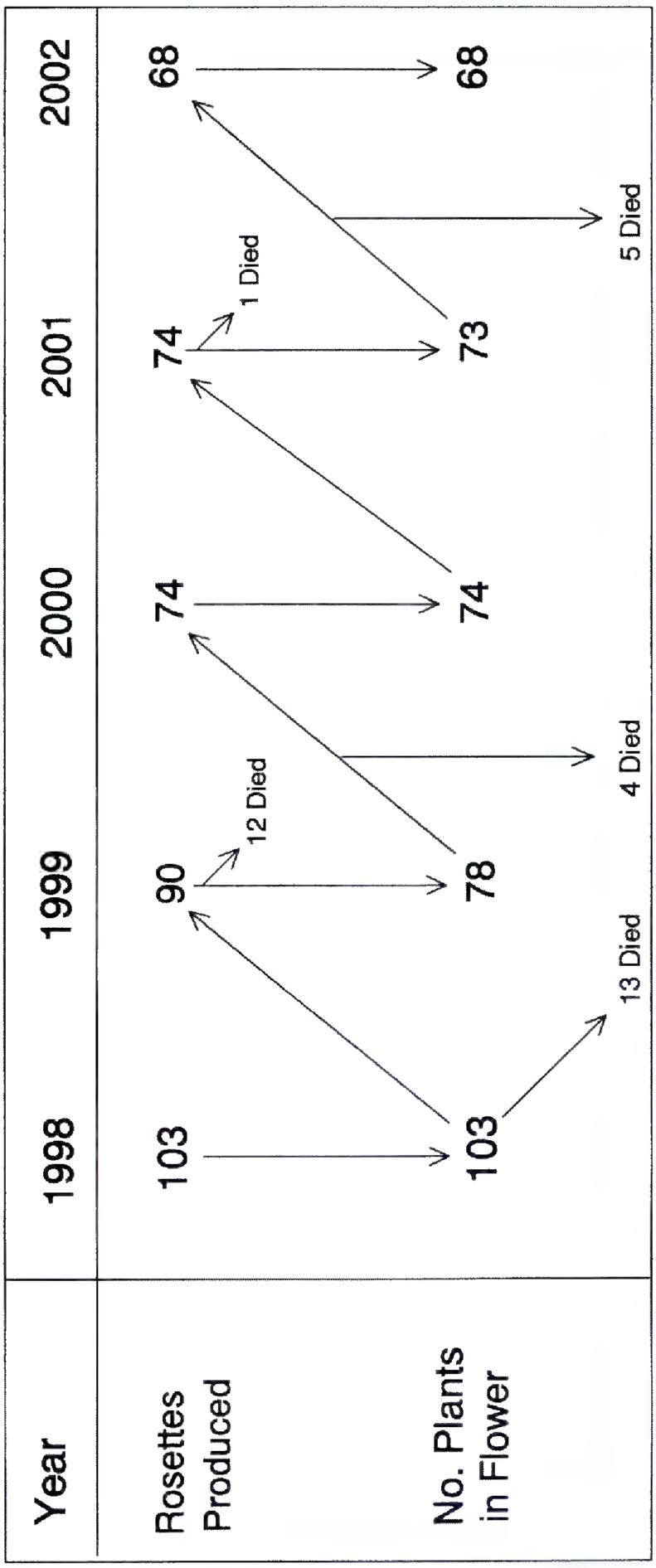


FIG. 2. Fate of 103 Alabama *Grindelia lanceolata* plants grown from seed in a non-heated greenhouse. All plants that produced rosettes in 1998 were in their second year of growth.

Number of seeds per plant produced during a single reproductive event was considerably higher in the monocarpic perennial ("biennial") plants (Tennessee) than in the polycarpic plants (Alabama). Salisbury (1942) reported that biennials in Great Britain produced an average of more than four times as many seeds as did polycarpic perennials. Duffy et al. (1999) predicted that monocarpic species should maximize the number of meristems (i.e., branches) devoted to reproduction, which would allocate as many reserves as possible to reproductive effort since there is only one reproductive event. Conversely, they predicted that polycarpic perennials should maximize the number of growth meristems (but not reproductive ones) since there is a fitness premium on longevity and competitive ability. Tennessee plants produced 2.2 times as many secondary basal stems, all of which flowered, as did Alabama plants. As a result, Tennessee plants produced, on average, significantly more capitula and had the potential to produce almost twice as many seeds as did Alabama plants. Thus, Tennessee plants obviously devoted more energy to reproductive meristems than did Alabama plants, which devoted more energy to growth in height and perennation. Whereas all Tennessee plants died after flowering once, the majority of Alabama plants continued to flower each year for several years. By producing fewer flowers, Alabama plants have reserve energy for production of new rosettes (i.e., perennation), which also should be considered growth meristems. Thus, there is a tradeoff between number of seeds produced per reproductive event and lifespan of an individual.

A very interesting difference between Tennessee and Alabama plants is life cycle type. In the nonheated greenhouse, both Tennessee and Alabama plants bolted and flowered in their second year. However, whereas all 88 Tennessee plants died after they reproduced once, only 13 of 103 Alabama plants did so. Thus, 100% of the Tennessee plants, but only 13% of the Alabama plants, behaved as biennials. Another 12% of the Alabama plants were dicarpic, 12% were tricarpic, and 1% tetracarpic, dying after their third, fourth, and fifth years, respectively. Sixty-six percent of the original 103 Alabama plants have flowered in their second, third, fourth, fifth, and sixth years, and it is expected that most of them could survive and flower for the next several growing seasons.

Apparently, differences in morphology, flowering time, and life cycle type between Tennessee and Alabama plants are genetically-based, since they were maintained in plants grown from seeds in a common environment. However, the advantage, if any, for *G. lanceolata* behaving as a short-lived monocarpic perennial in Tennessee glades, and of it behaving as a polycarpic perennial in the cedar glades in northern Alabama, is not known. Floristically and vegetationally, cedar glades of northern Alabama are very similar to those in central Tennessee (Baskin et al. 1995; Baskin & Baskin 1999, in press). Further, soils in both areas are limestone-derived, and climatic differences are minimal;

both areas are within Köppen's Cfa climate type (i.e., mild temperate rainy climate without a distinct dry season, and with a hot summer) (Ackerman 1941). Soil moisture and microclimate in cedar glades cause stress in plants in Tennessee glades (Baskin & Baskin 1999), and one would expect the same conditions in glades in Alabama. Thus, there are no apparent physical or biotic differences between Tennessee and Alabama glades that would seem to favor a monocarpic life cycle in one area and polycarpic life cycle in the other. A reciprocal transplant study would help to determine if, in fact, plants are subjected to different sets of selective factors on life history in the two areas, one favoring monocarpy and the other polycarpy.

In terms of r and K life history strategy (e.g., Pianka 1970), data collected in this study indicate that Tennessee plants are more r-selected than are Alabama plants, which are somewhat further along the r-K continuum to being K-selected. Thus, compared to Alabama plants, Tennessee plants are monocarpic, short-lived, smaller in stature, and much more productive in terms of numbers of seeds per reproductive event.

Could differences in geographic origin of Tennessee and Alabama plants account for the differences between them? Plants in Alabama glades could be disjunct from ancestor populations in southwestern United States, specifically in Texas. Texas floras (Correll & Johnston 1970; Enquist 1987; Nesom 1990) consistently describe the species as a (presumably polycarpic) perennial. This genetic race may have spread from Texas into Alabama, and the two groups became separated through geologic time. On the other hand, it seems likely that plants in the middle Tennessee cedar glades are disjunct from short-lived monocarpic or biennial races (Rydberg 1932; Wetter 1986; Gleason & Cronquist 1991) in the Ozark Region. Several other species, e.g., *Evolvulus nuttallianus* R. and S., *Oenothera macrocarpa* Nutt. subsp. *macrocarpa*, *Onosmodium molle* Michx. var. *subsetosum* (Mack. & Bush) Cronquist, and *Solidago gattingeri* Chapm. are disjunct between the limestone glades of Missouri and those in Tennessee, and none of these occurs in Alabama glades (Baskin & Baskin 1986; Bridges & Orzell 1986; Baskin et al. 1995; Baskin & Baskin in press).

ACKNOWLEDGMENT

The authors sincerely thank Mrs. Adrianna Sautu for translating the English version of the abstract into Spanish.

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BOOK NOTICES

LEONID AVERYANOV, PHILLIP CRIBB, PHAN KE LOC, and NGUYEN TIEN HIEP, watercolours by CAROL. WOODIN. 2003. **Slipper Orchids of Vietnam With an Introduction to the Flora of Vietnam.** (ISBN 0-88192-592-6, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, 800-327-5680, 503-227-2878, 503-227-3070 fax). $49.95, 327 pp., 340 color photos, 28 line drawings, 34 maps, 19 graphs, 7" × 10".

From the inside front dust jacket flap: "This book details the geology, climate and vegetation of Vietnam in all its remarkable diversity. The main text provides comprehensive accounts of the history, nomenclature and relationships of each of the 22 slipper orchid species and natural hybrids found within the country. It also provides the first detailed accounts of their habitats, biology and ecology. On a more urgent note it also highlights the imminent threat of extinction faced by many of them. Further urgent measures are necessary both within Vietnam and abroad to protect what remains." One new section is described: **Paphiopedilum** sect. **Emersonianum** Aver. et P.J. Cribb sect. nov. (p. 131).

GUY and LILIANE GUSMAN. 2002. **The Genus Arisaema: A Monograph for Botanists and Nature Lovers.** (ISBN 0-904144-91-X, hbk.). A.R.Gantner Verlag Kommanditgesellschaft, FL 9491 Ruggel. (Orders: Koeltz Scientific Books, PO Box 1360, D 61453 Konigstein, Germany, +49 6174 93720, fax +49 6174 937240, email: koeltz@t-online.de, www.koeltz.com). $49.95, 438 pp., numerous color photos, line drawings, 6 1/4" × 9 1/2".

From the dust jacket: Since Engler's classification in 1910, this monograph is the first attempt to bring order to the confused state of knowledge about the genus in the whole of its geographical range. It includes descriptions, taxonomy, names and synonyms, critical examinations of the nomenclature, geographic distributions and habitats together with notes on cultivation, providing the most up-to-date account of the genus *Arisaema* available today."

New names and new nomenclatural combinations proposed: Section **Anomala** G. & L. Gusm. sect. nov. (p. 61); Section **Arisaema** G. & L. Gusm. stat. nov. (p. 95), Section **Lobata** G. & L. Gusm. sect nov. (p. 215); **Arisaema elephas** var. **handelii** (Stapf ex Hand.-Mazz.) G. & L. Gusm. var. nov. (p. 110); Section **Pedatisecta** subsection **Pistillata** (Engl.) G. & L. Gusm. stat. nov. (p. 233); Section **Pedatisecta** subsection **Pedatisecta** (Schott) G. & L. Gusm. stat. nov. (p. 234); Section **Sinarisaema** subsection **Sinarisaema** (Nakai) G. & L. Gusm. stat. nov. (p. 296); Section **Sinarisaema** subsection **Exappendiculata** (Hara) G. & L. Gusm. stat. nov. (p. 296); Section **Tortuosa** subsection **Attenuata** (Engl. p.p.) G. & L. Gusm. stat. nov. (p. 365); **Arisaema yunnanense** var. **aridum** (H. Li) G. & L. Gusm. var. nov. (p. 110).

THE NAME OF THE AMARANTH: HISTORIES OF MEANING[1]

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ABSTRACT

The cultivated grain and the weedy *Amaranthus* L. species (section *Amaranthus*) originated in the Americas. The Spaniards conquered the New World in the 16th century. Consequently, the North American species of *Amaranthus* could not have been introduced in Europe before this date. However, the name of the amaranth existed long before its association with plants in the genus described by Linnaeus. Several everlasting plants were named "amaranth" by the ancient Greeks and Romans, and in the medieval times. Among these, *Helychrisum* spp. and *Celosia argentea* L. are the most common. The name "Amaranthus" has had multiple meanings and ramifications through time: botanical, ethnobotanical, religious, literary and philosophical. This paper explores this history of meanings of the name "Amaranthus."

RESUMEN

Las especies cultivadas como pseudocereales y las malas hierbas de *Amaranthus* L. (sección *Amaranthus*) tuvieron su origen en las Américas. Los españoles conquistaron el Nuevo Mundo en el siglo dieciséis. Consecuentemente, las especies norteamericanas de *Amaranthus* no se pudieron haber introducido en Europa antes de esta fecha. Sin embargo, el nombre del amarantho existió mucho antes de su asociación con plantas del género descrito por Linneo. Varias plantas fueron denominadas "amaranth" por los griegos y romanos antiguos, así como en los tiempos medievales. Entre éstos, *Helychrisum* spp. y *Celosia argentea* L. fueron algunos de los más comunes. El nombre "Amaranthus" ha tenido múltiples significados y ramificaciones a través del tiempo: botánicos, etnobotánicos, religiosos, literarios y filosóficos. Este artículo explora esta historia de significados del nombre "Amaranthus."

INTRODUCTION

The genus *Amaranthus* of Linnaeus includes species that originated in the Americas, Africa and Eurasia. The association between these plants and the name *Amaranthus* is relatively recent. American cultivated grain amaranths (*Amaranthus caudatus* L., *A. hypochondriacus* L. and *A. cruentus* L.) and their wild relatives (*A. hybridus* L. and *A. powellii S. Wats.*) were introduced in Europe in the 16th century, after Spaniards conquered the New World (Sauer 1950, 1967). Other *Amaranthus* species, such as *A. tricolor* L. from Asia, and *A. blitum* L. from Eurasia were also associated with this name in or after the 16th century (Gerard 1633; Thellung 1914). Yet, the name of the amaranth had been used by the ancient Greeks and Romans almost two millennia before. Therefore, the

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[1]"Stat (rosa) pristina nomine/Nomina nuda terminus" U. Eco, The name of the rose, the final Latin hexamer.

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question is: what was the ancient amaranth and how did the meaning of this name changed in time? An investigation into the history of the name "Amaranthus" revealed multiple meanings and ramifications through time: botanical, ethnobotanical, religious, literary and philosophical. This paper is an attempt to tell the story of the name of the amaranth.

Etymology and Nomenclature

Amaranthus L. Sp. pl.:989. 1753. = *Amaranthus* Adans. Fam. Pl. II, 269, 516. 1763.

The ancient Greek name used by Dioscorides (4:57, Gunther 1959), ἀμάραυτοζ (amárantos) came from the adjective ἀμάραυτοζ, unfading (alpha privative, not + maraíno, fading), alluding to the everlasting nature of the flowers and inflorescences. In ancient Greece, *Amaryntus* was a village in Euboea, where *Amaryntium*, the temple of Artemis *Amaryntia* was situated (Strabo, The Geography 10:10, 12; 1959–1961). However, these names probably derived from the same etymology. The Latin form adopted by Pliny the Elder (Natural History 21:41, 1951) was "amarantus." Instances when the word was not associated with a plant can be found in the Greek New Testament, 1 Peter 5:4, "*ton amarantinon tes doxes stephanon*" ("the unfading crown of glory") and 1 Peter 1:4, "*kai amaranton*" ("will not fade away") (see Rienecker 1980). Lucianus Samosatenis described a fresco painting of a flowery meadow as "eternal spring and unfading (*amarantos*)" (The Hall 9, 1949).

Later, Tournefort (1694) stated that the name came from the alpha privative (α)—"not," and the words "*marceo*" (the Latin equivalent of "maraino")—"to fade," meaning "never fading" and "*anthos*" (ἀνθοζ)—"flower." As Ray (1686–1688) observed, the second analogy was forced: "*Amarantus male cum 'th' scribitur Amaranthus.*" Thellung (1914) also noted that if the word "*anthos*" had been incorporated in the etymology, the name should have been "*Amarananthus*" and not "*Amaranthus.*" Both *Amarantus* and *Amaranthus* were used in the 16th and 17th century (reviewed by Sprague 1928). However, Linnaeus knew both forms and deliberately rejected the classical spelling *Amarantus* in favor of *Amaranthus* (Sprague 1928). The retention of the original *Amaranthus* spelling should be followed even if it is less desirable philologically (Saint Louis Code, article 60.1).

The Huauhtli.—Amaranths were called *huauhtli* by the Aztecs (see Wimmer 2003). We wanted to see if "unfading" served as an etymological root for *huauhtli* in the same way it did for *Amaranthus*. "*Huauh-*" in the Nahuatl of the 16th century was an independent nominal radical, connected with no other root. "*Huâqui*," to dry, would give the name "*huâctli*," a dried out thing, word which unfortunately could not be retraced to any old uto-aztecan roots (Wimmer, pers. com.). The history and ethnobotany of *huauhtli* are fascinating since its relationship with man goes back more than 6000 years (Sauer 1950; Cole 1979). The

uses of *huauhtli*, and its social, religious and economic significance during the Aztec Empire, are well known today (e.g. Sauer 1950, 1967; Cole 1979; Early 1992). *Huauhtli* played an important role in many Aztec religious ceremonies. Huge idols were molded from the dough prepared from *huauhtli* flour and popped grains, which were then mixed with honey and sometimes with blood. The idols were dedicated to several gods, among which the war god Huitzilopochtli was the most prominent. The rituals involved human sacrifices and the Spanish conquistadors tried to suppress the "pagan" culture by prohibiting the cultivation of the *huauhtli* (Sauer 1950; Cole 1979). Crop fields were burned and Aztec people killed if they were found to possess the plant or its grains. Despite their efforts, the conquistadors could not eradicate *huauhtli* and the plants endured the time, awaiting their new name.

The Amaranth: Several Everlasting Plants.—The name of the amaranth preceded the introduction of *huauhtli* in Europe in the 16th century. It also preceded the introduction of *A. tricolor* L. from Asia in the 16th century. Another Euroasian species, *Amaranthus blitum* L., was known in ancient Greece as "*blite*" (Theophrastus Book 1. 14:2, Book 7. 1:2–3, 3:2, 3:4, 14:2, 1916; Dioscorides 2:143, see Gunther 1959), and it became associated with the name *Amaranthus* only in the 17th century (Thellung 1914). The ancient amaranth was an everlasting plant used by the ancient Greeks for garlands of deity statues and in death rituals. Dioscorides (4:57, Gunther 1959) mentions ἀμάραντοζ (amarantos) as a synonym for *elichruson* (*Helychrisum* spp., most probably *H. arenarium* (L.) Moench), an everlasting plant with yellow flowers (phyllaries) used by the Greeks "to crown idols." "The hair (the inflorescences) being drank with wine doth help Dysuries, & ye bitings of serpents, & Sciaticas, & ruptures, & it moves ye menstrua, & consumes the clots of blood which are in ye bladder or ye belly, being drank with mustum" (Dioscorides 4: 57, Gunther 1959). The yellow amaranth mentioned several times in Vatsyayana's Kama Sutra, may also be *Helychrisum* (Burton 1963).

During the Roman Empire, Pliny the Elder described "Amarantus" as "*autem spica purpurea verius quam flos aliquis*" (Natural History 21:41, 1951). The description indicates that the amaranth at that moment was probably *Celosia argentea* L., an Amaranthaceae from Asia and Africa that resembles *Amaranthus* spp. in many respects. Indeed, the author distinguished the amaranth from *Helichrysum* (21:168), and the latter retained all the characteristics and uses previously mentioned by Theophrastus and Dioscorides. However, it should be noted that the name of the amaranth was again associated with an everlasting plant. The amaranth referred to by Ovid (4:435, 1931), Tibullus Albius (3.4.33, 1962), Plutarch (Questiones convivales 3.13.648A, 1949) and Columella (10:175, 1941) was also *C. argentea*. In the 15th and 16th century, the name *Amaranthus* (or *Amarantus*) was applied equally to *Helychrisum* spp., to the

amaranths introduced from the New World, to *C. argentea*, and even to *Gomphrena globosa* L., another Asian Amaranthaceae. For example, in 1542 Fuchs described and illustrated two amaranths ("*flos-amoris*"): "*Duplex est Amarantus: unus luteus* (*Amarantus luteus* = "Helychrison" = *Helychrisum arenarium*) [...], *alter purpureus*" (*Amarantus purpureus* = *C. argentea*) (De Historia Stirpium 98–101, 1542). Matthioli's illustration of the amaranth from 1563 (in Krutch: 128, 1976; Fig. 1) is also probably *C. argentea*. Henry Fletcher, a painter active in London around 1730, in a reproduction of a Pieter Casteels' painting, identified a plant of *C. argentea* as "yellow Amaranthus" (see Segal 1990). "Floramore" or "Flour Amore" was equally a popular name for *Amaranthus tricolor*, for *Celosia argentea* (= *Amaranthus purpureus*, Gerard 1633; Henry 1829; Fisher 1998) and for the real amaranths ("Amaranthus Pannicula Sparsa," Gerard 1633; see also Meyer et al. 1999). The confusion is understandable. *Amaranthus* and *Celosia* are similar in many respects, and North America was thought initially by Christopher Columbus to be a part of Asia. It is difficult to ascertain who was the first botanist to distinguish the two genera and who was the first to associate the name with today's amaranths. The distinctive in florescence of *A. caudatus* was described by Parkinson (1640. 753) and Ray (1686–1688, 1: 202). Although Ray did not mention *Celosia*, his "*Amarantus*" was classified accurately in the group with "*herbae florae imperfecto sexu carentes sunt vel femine*" (Methodus Plantarum, Tab. 5, 1684) (*Celosia* has bisexual flowers). It was Linnaeus who legitimized the differences between the two genera (*Celosia* Sp. Pl. 205. 1753; for *Amaranthus* see above).

The Amaranth: A Magical Plant.—Theophrastus, who preceded Dioscorides by approximately 300 years, did not mention *Amaranthus*. He wrote about the "magical properties" of the gold-flower (*Helychrisum* spp.), which was capable of bringing fame and wealth to those who wreathed themselves with the flowers sprinkled with an "unguent from a vessel of unfired gold" (Book 9, 19:2–4, 1916). However, Theophrastus was skeptical about "such tales ... (which) proceed from men who desire to glorify their own crafts." Athenaeus of Naucratis cited Theophrastus, but in a credulous tone, affirming that the plant really is magical and capable of bringing fame and fortune (15:680, 1955–1961). Medieval herbalists followed Dioscorides' synonymy and transferred the virtues of the "helichruson" to the amaranth. Joannes Ammonius Agricola called amaranth "*flos honoris*" (Medicinae Herbariae:35, 1539) because the flower was capable of bringing honor. Since "its flowers (are) dedicated to the gods and rarely to living men," dreaming garlands of amaranth (was) a bad sign for sick people but a good one "for everyone, especially for people involved in lawsuits" (Artemidorus Daldianus 1:77, 1975). English colonists sailing for America wore magical amulets containing amaranth seeds to protect them (Cole 1979). Later, in the 19th century Americans believed that the amaranth could attract light-



FIG. 1. "Amaranthus" from Matthioli 1563, probably *Celosia argentea* L.

ning (Cole 1979). Today, hundreds of Web pages and magic books recommend amaranth as the flower of "protection, healing and invisibility" (e.g. Cunningham 1993a, b). Wearing a wreath of amaranth speeds healing (even of a broken heart) and grants invisibility. Fragments of an amaranth plant, collected on Friday night under a full moon, can even protect you against bullets... We wonder what Theophrastus would say to this?

The Amaranth and the Types of Immortality.—"Eternity points, in its amaranth bower" (Shelley, Bereavement, 1901). The quest for eternity and immortality is one of the major inquietudes of the human spirit. Physical or spiritual immortality, everlasting love and friendship, eternal happiness and virtue are different coordinates of the same obsessional geography of ideas. Amaranth was chosen as a symbolic flower to capture all of these meanings. That is why an exploration into the meanings of the amaranth name is at the same time a taxonomy of the types of immortality.

Immortal youth (life).—The first metamorphosis of the amaranth from an everlasting plant into an immortality symbol can be found in one of Aesop's fables (the Rose and the Amaranth, 384, 1975). The Amaranth, envious of the "beauty and perfume" of the Rose receives the following reply: "I indeed, dear Amaranth, flourish but for a brief season! If no cruel hand pluck me from my stem, yet I must perish by an early doom. But thou art immortal and dost never fade, but bloomest for ever in renewed youth" (Aesop, Fables: The rose and the amaranth, 384, 1975).

Immortal hero and everlasting virtue.—At the funeral of Achilles, Thetis and the Muses spread "immortal weeds" on his grave (Homer, "Odyssey" 24:43–29, 1955). According to more recent sources that we could not trace in classical authors, the Thessalians placed amaranth on the funerary monument of Achilles (Thylesius Antonius 1531) or wore amaranth crowns at his funeral (Genlis 1810–1811). For Cowper, "the only amaranthine flower on earth is virtue" (The Task, Book 3: The garden, 1874) and for Sainte-Beuve the amaranth is a "symbol of virtue that never fades" (Causeries du lundi, vol. 8:142, 1926 – 1947).

Immortal love and hope.—The following verses of Gombault were taken from Henry's Flora Historica (1829): "*Je suis la fleur d'amour qu'amarante on appelle/ Et qui vient de Julie adorner les beux yeux./ Roses, retirez-vous, j'ai le nom d'immortelle,/ Il n' appartient qu'à moi de couronner les dieux.*" The old Victoran name of *A. caudatus*, "love-lies-bleeding," is in direct relation with the shape and the blood red color of the inflorescence. "Hope without an object cannot live" and the amaranth is for Coleridge a symbol of eternal hope (Work without hope, 1972).

Immortal soul.—Although Pliny's description of the amaranth was utilitarian, his words were later interpreted in a symbolic or mystical way: "*mireque, postquam defecere cuncti flores, madefactus aqua revivescit et hibernas coronas*

facit. summa natura eius in nomine est, appellati, quoniam non marcescat" (Natural History 21:41, 1951). In the Roman Empire of the second century AD, the custom of wearing wreaths was regarded as a pagan practice by Tertullian (1992) and Clement of Alexandria (1965–1983), a sacrilege to the crown of thorns worn by Christ. For Clement, the amaranth became an imaginary immortal flower, which grew only in Paradise and was offered as an eternal reward to good Christians. "The earth is not capable of producing this flower; heaven alone knows how to grow it" (Pedagogos 2.8.73, 1965–1983). As Irwin (1990) pointed out: "Clement ... was certainly not simply transplanting an actual earthly flower to heaven." He was adding two new dimensions to Aesop's symbol of immortality: the spiritual and the sacred. More than 400 years after Clement, Milton envisions the same heavenly amaranth, but his vision of the "immortal amaranth" is purely metaphorical:

"With solemn adoration down they cast
Their Crowns inwove with Amarant and Gold.
Immortal Amarant, a Flour which once
In Paradise, fast by the Tree of Life
Began to bloom, but soon for mans offence
To Heav'n remov'd where first it grew, there grows,
And flours aloft shading the Fount of Life,
And where the river of Bliss through midst of Heaven
Rowls o're Elisian Flours her Amber stream"
(Book III, 351–360, and see also XI, 77–81, 1948).

Another, less solemn, type of heavenly amaranth can be found in Charlotte Brontë: "Happiness is a glory shining far down upon us, out of heaven. It is a divine dew which the soul, on certain of its summer evenings, feels dropping upon it from the amaranth bloom and golden fruitage of Paradise" (Brontë, Villete, Chapter 22, The letter, 1984).

Sacred amaranth.—In the 13th century, the name became an attribute of the Virgin Mary, a symbol of immaculate immortality: "*Amaranthus flos, sacro, qui non marcet, honore vigens*" (Johanes Germanus 1460 in Marraccio 1693). In a painting by Botticini, amaranth plants grow from the ruins of the palace of David where Madona adores the sacred child (D'Ancona 1977). In Southern Europe, amaranth was used to decorate churches on Ascension Day (Skinner 1925; Cole 1979), and some of the popular names included "the scourge of our Blessed Lord" (Dowling 1900) and "Discipline de Religieuse" (Henry 1829). It should noted that blood symbolistic, divine or not, is a convergence point between the Aztecs and the Old World.

Hermetic amaranth.—In 1653, Christina, Queen of Sweden, founded the hermetic Order of the Amaranth (Åkerman 1991). The emblem consisted of an insignia with a double A, a crown of amaranth, and the inscription "*dolce in nella memoria.*" Henry (1829) mentioned the above inscription as appearing on a medal with an Amaranth in enamel. The exact type of immortality sought

by Christina can only be speculated: catholic ideal of virginity, everlasting and imperishable glory or immortal mystical bond (see Åkerman 1991). At least one of the aims was achieved because the Queen is still "*dolceinnella memoria*." The emblem and the name have been embraced by the current Masonic Order of the Amaranth (Order of the Amaranth 1994).

A Plant or a Symbol?—"...Sad Amaranthus, in whose purple gore/...To whom sweet Poets hath given endlesse date" (Spenser, The Faerie Queene, book III, canto VI, 406–408, 1976). Hundreds of writers, poets and sometimes even musicians have carved and deepened (or occasionally weakened) the name of the amaranth. Some of them are probably not aware that the amaranth is an earthly plant and not an abstract sign or symbol. This particular case illustrates the disparity between the symbolism and the reality of many names. The dispute over the presence of an existential relationship between a name and the named thing recurs from Plato's Cratylus to modern semiotics. Whether the name is a simple convention (as Hermogenes believed in Cratylus, Plato, 1926), a sign that signifies (Wittgenstein, Tractatus logico-philosophicus:3, 1992), or more than that is not for us to determine. This name traveled in time from plant to plant until it found its perfect mach. Grain amaranths are "from the past for the future" (Cole 1979) and as weeds they will be "a perpetual source of trouble to farmers" (Macoun 1883). At the same time, the meanings conveyed by the name have probably changed our perception of the plants. Perhaps the amazing history of the *huauhtli* plants in the New World would have faded away without the unfading symbolism of their new name. One thing is certain: the amaranth will continue to grow, here or in Paradise as long as we do, or perhaps even longer.

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BOOK NOTICES

JOHN G. SEMPLE, STEPHEN B.HEARD, and LUC BROUILLET. 2002. **Cultivated and Native Asters of Ontario (Compositae: Astereae): Aster L. (including *Asteromoea* Blume, *Diplactis* Raf. and *Kalimeris* (Cass.) Cass, Callistephus Cass., Galatella Cass., Doellingeria Nees, Oclemena E.L.Greene, Eurybia (Cass.) S.F. Gray, Canadanthus Nesom, and Symphyotrichum Nees (including *Virgulus* Raf.).** (ISSN 0317-3348, pbk.). University of Waterloo Biology Series 41. (Orders: U.W. Biology Series, Department of Biology, University of Waterloo, Waterloo, Ontario, N2L 3G1, CANADA, www.science.uwaterloo.ca/biology/jcsemple/uwbioser.htm). $20.00, 134 pp, 61 plates/line drawings, 8 3/8" × 10 5/8".

Eighteen new nomenclatural combinations are proposed.

ROBERT R.HAYNES and LARUITZ B. HOLM-NIELSEN. 2003. **Potamogetonaceae.** (ISBN 0-89327-443-7, pbk.). Flora Neotropica Vol. 85. New York Botanical Garden Press, 200th Street and Kazimiroff Blvd, Bronx, NY 10458-5126. (Orders: 718-817-8721, fax 718-817-8842, email: nybgpress@nybg.org, www.nybg.org). $15.00, 56 pp, line drawings, 7" × 10".

"This work addresses two genera of Potamogetonaceae known form the Neotropics (*Potamogeton* and *Stuckenia*), a family of aquatic herbs with submersed or floating leaves. Haynes and Holm-Nielsen provide treatments of 17 neotropical species of *Potamogeton* and three neotropical species of *Stuckenia*. Included are keys, descriptions, illustrations, and documented distribution maps for the species and subspecies discussed."

DOCUMENTED CHROMOSOME NUMBERS 2003: 1. CHROMOSOME NUMBER OF *TOXICOSCORDION NUTTALLII* (LILIALES: MELANTHIACEAE) AND CLARIFICATION OF THE GENUS

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ABSTRACT

The mitotic chromosome count for *Toxicoscordion nuttallii* ($2n = 22$), reported here, matches the number formerly documented for other species in the genus. A previous unvouchered report of $2n = 32$ for this species, therefore, likely represents a misidentification, and a base number of $x = 11$ is synapomorphic for *Toxicoscordion*. An updated overview of this recently resurrected segregate genus is given.

RESUMEN

El recuento de cromosomas mitóticos en *Toxicoscordion nuttallii* ($2n = 22$), citado aquí, concuerda con el número documentado anteriormente para otras especies del género. Un reporte previo, sin catalogar, de $2n = 32$ para esta especie, probablemente representa una identificación incorrecta y el número base de $x = 11$ es sinapomórfico para *Toxicoscordion*. Aquí se presenta una revisión de este género segregado recientemente resucitado.

Tribe Melanthieae (Liliales: Melanthiaceae) comprises seven genera (ca. 62–93 spp.) of predominately woodland and/or alpine perennial herbs occurring mainly in the temperate to Arctic zones of the Northern Hemisphere: *Amianthium* (1 sp.), *Anticlea* (9–11 spp.), *Schoenocaulon* (24 spp.), *Stenanthium* (2–3 spp.), *Toxicoscordion* (8 spp.), *Veratrum* s.l. (17–45 spp.), and *Zigadenus* s.s. (1 sp.). These generic circumscriptions (most novel) are supported by recent parsimony analyses of *trnL-F* (plastid) DNA and ITS (nuclear ribosomal) sequence data (Zomlefer et al. 2001, 2003). A significant consequence of the molecular studies was the reassessment of the traditional *Zigadenus* s.l., a poorly defined assemblage with a complex taxonomic history (summary in Zomlefer 1997). Although several segregates of *Zigadenus* have been described, contemporary treatments (e.g., Schwartz 2002) have typically accepted only the monotypic segregate *Amianthium* with the remaining ca. 19 species maintained in *Zigadenus* s.l. Based on these molecular data, however, *Zigadenus* s.l. is polyphyletic and forms five strongly supported clades that correlate with certain geographical distribution, morphological characters, and chromosome number.

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One well-defined clade corresponds to the genus *Toxicoscordion*, originally described by Rydberg (1903), and recognized as a distinctive taxon by both Preece (1956) and Schwartz (1994) as *Zigadenus* sect. *Chitonia* (R.A. Salisbury) J.G. Baker. This *Zigadenus* segregate comprises ca. eight species (Table 1) restricted to the midwestern United States to western North America (Fig. 1A) and includes the well-known poisonous "death camas" plants of the rangelands such as *T. nuttallii*, *T. paniculatum*, and *T. venenosum* (see Marsh et al. 1915, 1926). The resurrection of *Toxicoscordion* required one new combination (*T. fontanum*), a species described within *Zigadenus* by Eastwood (1937), long after Rydberg (1903) had circumscribed the genus and had transferred the appropriate contemporary *Zigadenus* species. *Toxicoscordion* is defined by the morphological synapomorphies of conspicuously clawed tepals (especially the inner three) and one obovate gland per tepal (Fig.1B; Zomlefer et al. 2001; Zomlefer & Judd 2002). Although a discrete genus, specific and infraspecific limits are unclear, especially within the variable *T. micranthum–T. fremontii* species complexes and the intergrading *T. paniculatum–T. venenosum*. For example, in an isozyme study of these species (Schwartz 1994), the monophyly of *T. paniculatum* is suspect because the five sampled populations were separated from each other in UPGMA cluster analyses and distance Wagner trees. These results warrant further examination of the species complexes in the genus.

The chromosome number $2n = 22$ (or $n = 11$) has been reported for all species of *Toxicoscordion* (Table 1; Fig. 2) except for one anomalous report of $2n = 32$ for *T. nuttallii*. Since chromosome number is a significant and likely an invariable apomorphy for genera of tribe Melanthieae (e.g., Zomlefer and Smith 2002), 22 is the predicted mitotic count for all *Zigadenus* species now transferred to *Toxicoscordion*. This study challenges the earlier conflicting *T. nuttallii* report, thereby seeking to validate the diploid number of 22 as a consistent synapomorphy for the genus.

MATERIALS AND METHODS

Several bulbs of *Toxicoscordion nuttallii* were collected during April 2002 at two localities in south-central Texas by J. Spangler and T. Wendt (see Table 2) and transplanted to pots maintained at the Plant Biology Dept. Greenhouse Facility at the University of Georgia. Dividing root tip cells were prepared for examination with some modification of the general protocols outlined by Flory and Smith (1980) and Jones and Luchsinger (1986). Once the plants were well-established, actively growing root tips were harvested at 8:00 AM and treated with 0.2 % colchicine for 4 hours, rinsed in distilled water, and then fixed in Carnoy's solution (3 ethanol: 1 acetic acid) overnight or longer. Following this fixation, the roots were rinsed in distilled water and stored under refrigeration in 70% ethanol. The material was subsequently hydrolyzed in 1.0 N HCl at 53° C for 5 minutes, rinsed several times again with water, and treated with 45%

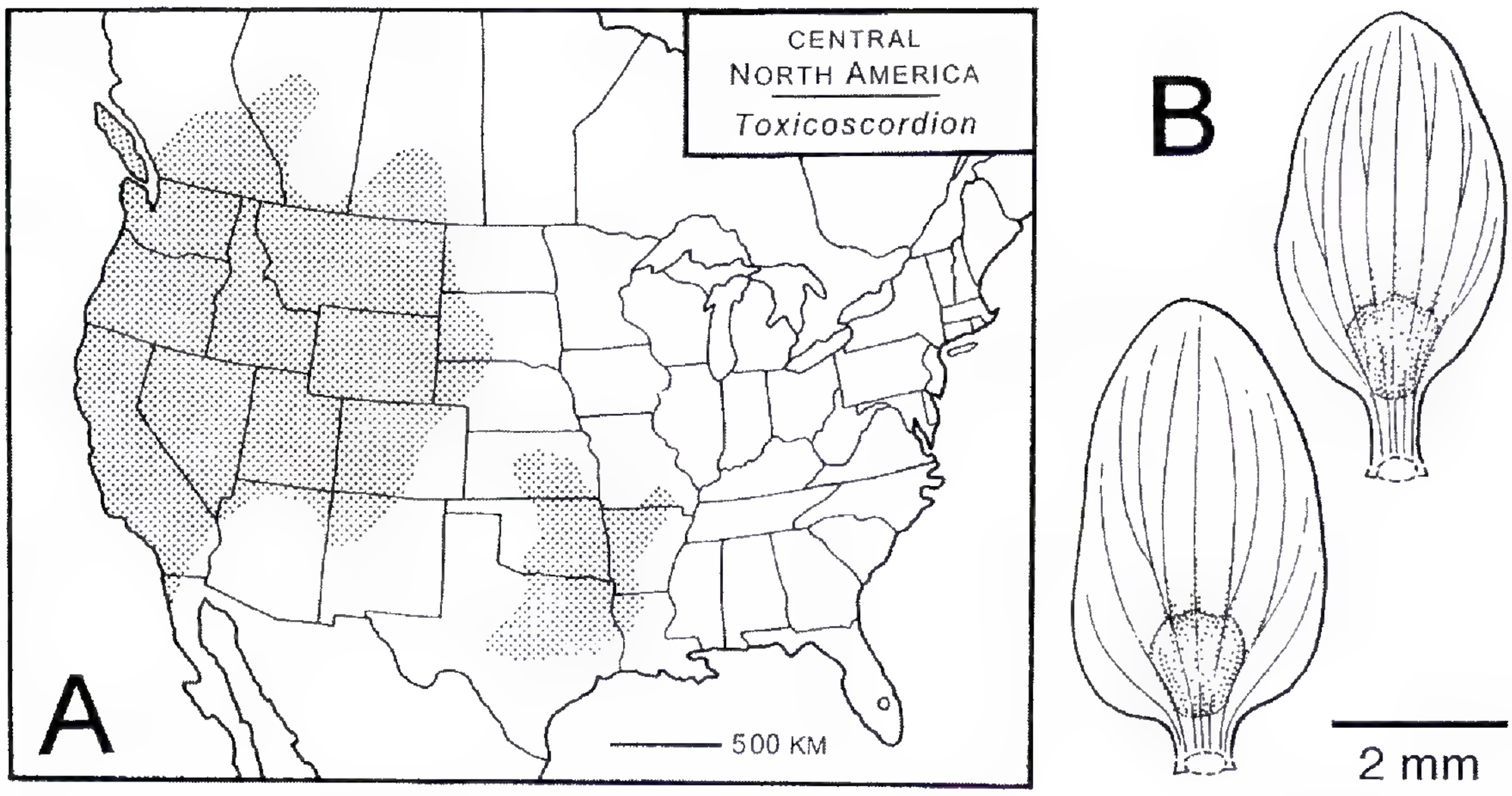


FIG. 1. Distinctive characteristics of *Toxicoscordion*. **A.** General distribution map of *Toxicoscordion* (data from Walsh 1940; Preece 1956; Schwartz 1994, 2002; M. H. MacRoberts pers. comm.). The midwestern disjunct range (Texas–Oklahoma–Kansas–Missouri–Arkansas–Louisiana) comprises the localities of *Toxicoscordion nuttallii*. **B.** Adaxial surface of an outer (left) and an inner (right) tepal from *T. nuttallii* (*Rollins 5334*, GH), showing the generic autapomorphies: claw plus a single obovate gland. Dashed ellipse = filament insertion. The claws of the inner tepals are typically more pronounced than those of the outer whorl.

glacial acetic acid for 10 minutes. The growing tips were then removed, macerated with a dissecting spatula on a glass microscope slide, and stained with 1% aceto-orcein. After application of a cover slip, the slide was gently heated with an alcohol lamp, placed between blotters, and subjected to additional pressure. Slides were mounted in euparal for future reference. Well-spread metaphase (and late prophase) chromosomes were traced under a Leica DMLB Research Microscope with a camera lucida attachment. Herbarium specimen vouchers (Table 2) are deposited at GA and TEX.

RESULTS AND DISCUSSION

The mitotic chromosome number of $2n = 22$ for *Toxicoscordion nuttallii* is confirmed with plants from populations in Hays and Williamson Counties, Texas (Fig. 2E, F; Table 2). A citation of $2n = 32$ for *T. nuttallii*, originally reported by Zakharieva and Makushenko (1969) and subsequently cited in various indices and floras (e.g., Fedorov 1969; Moore 1971, 1973; Churchill 1986; Yatskievych 1999), was based on an undescribed and unvouchered plant then growing at the Munich Botanical Garden (original source not cited). This "*Zigadenus*" species was likely an *Anticlea*, another *Zigadenus* segregate, but one characterized by $x = 8$ (Zomlefer & Judd 2002).

Chromosome number is a useful taxonomic character for genera within tribe Melanthieae, especially the synapomorphic $2n$ numbers of 20 for

TABLE 1. The species of *Toxicoscordion* and their mitotic (*2n*) and/or meiotic (*n*) chromosome numbers. The single citation for *T. nuttallii*, *2n* = 32, is inconsistent with reports for all other species in the genus.

Taxon	Chromosome Number n	2n	Secondary Citation(s) in Indices and Floras	Original Source(s)
T. brevibracteatus (M.E. Jones) R.R. Gates	11	—	Cave (1960); Fedorov (1969); Moore (1972, 1973); McNeal (1993)	Lewis (1959); Cave (1970)
T. exaltatum (Eastwood) A. Heller	11	—	McNeal (1993)	?
T. fontanum (Eastwood) Zomlefer & Judd	11	—	Moore (1972, 1973); McNeal (1993)	Preece (1956, as *Zigadenus venenosus* var. fontanus); Cave (1970)
T. fremontii (J. Torrey) Rydberg	11	—	Darlington & Wylie (1956); Fedorov (1969); Moore (1972, 1973); McNeal (1993)	Miller (1930); Preece (1956, as *Zigadenus fremontii* var. *fremontii*); Cave (1970, as *Z. fremontii* var. *fremontii* and var. *inezianus*)
T. micranthum (Eastwood) A. Heller	11	—	McNeal (1993)	Preece (1956, as *Zigadenus venenosus* var. *micranthus*)
T. nuttallii (A. Gray) Rydberg	—	32	Fedorov (1969); Moore (1971, 1973); Churchill (1986); Yatskievych (1999)	Zakharyeva & Makushenko (1969)
T. paniculatum (Nuttall) Rydberg	11	22	McNeal (1993)	Preece (1956)
T. venenosum (S. Watson) Rydberg	11	22	Moore (1972, 1973); Goldblatt (1981); Churchill (1986); McNeal (1993)	Preece (1956, as *Zigadenus venenosus* var. *gramineus* and var. *venenosus*); Cave (1970); Taylor & Taylor (1977, as *Z. venenosus* var. *gramineus*); Hartman & Crawford (1971, as *Z. venenosus* var. *gramineus*)

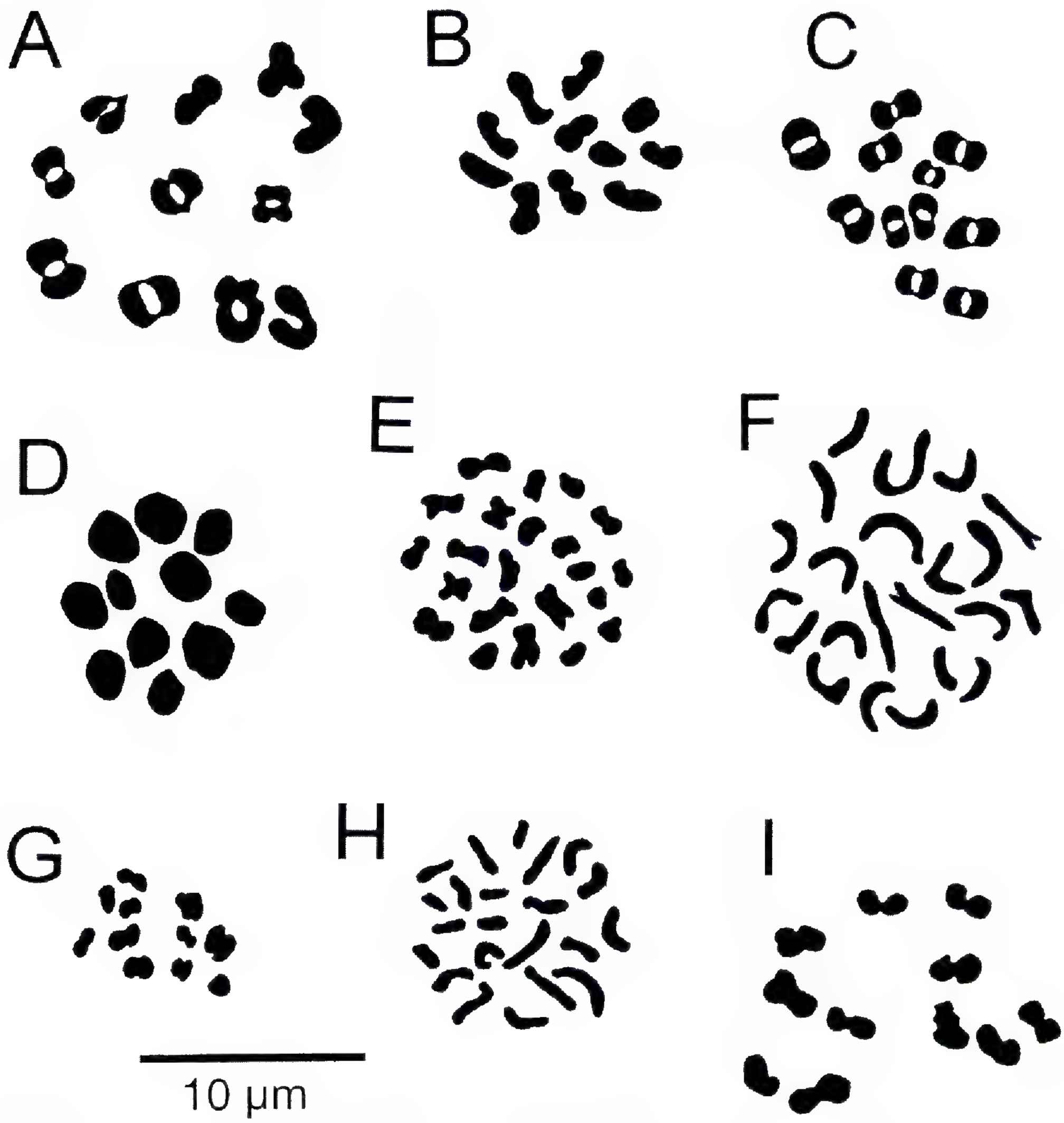


FIG 2. Summary illustration of previously documented meiotic ($n = 11$) and/or mitotic ($2n = 22$) chromosomes of *Toxicoscordion* (A–D, G–I) and the new reports for *T. nuttallii* (E, F: $2n = 22$). **A.** *T. brevibracteatus*, diakinesis ($n = 11$). **B.** *T. fontanum*, anaphase II ($n = 11$). **C.** *T. fremontii*, metaphase I ($n = 11$). **D.** *T. micranthum*, metaphase I ($n = 11$). **E.** *T. nuttallii* (*Wendt 7246*, TEX), metaphase ($2n = 22$). **F.** *T. nuttallii* (*Spangler s.n.*, GA), late prophase ($2n = 22$). **G.** *T. paniculatum*, metaphase ($2n = 22$). **H.** *T. paniculatum*, metaphase I ($n = 11$). **I.** *T. venenosum*, metaphase I ($n = 11$). Figures A, B, and I modified from Cave (1970); Figs. C, D, G, and H modified from Preece (1956).

Stenanthium (Zomlefer & Judd 2002) and 22 for *Toxicoscordion*. A probable base chromosome number of $x = 8$ is often cited for the tribe (Sen 1975; Tamura 1995; Lowry et al. 1987; Zomlefer 1997), and multiples of this number are prevalent in other genera of the tribe: *Amianthium* ($2n = 32$), *Anticlea* (including *Stenanthella*; $2n = 32$), *Schoenocaulon* ($2n = 16$), and *Veratrum* (including *Melanthium*; $2n = 16, 32, 64, 80, 96$). Due to the small size of the chromosomes

TABLE 2. Voucher specimens for the chromosome numbers of *Toxicoscordion nuttallii* reported in this study.

Taxon	Locality and collection number (voucher location)	Mitotic chromosome number (2n)
Toxicoscordion nuttallii	TEXAS. HAYS CO.: Between Driftwood and Dripping Springs, along FM 150, 3.7 mi N of FM 1826, 15 Apr 2002, *Wendt 7246* (TEX)	22
	TEXAS. WILLIAMSON CO.: Austin, 0.25 mi from 8521 Foxhound Tr., 3 Apr 2002, *Spangler s.n.* (GA)	22

(ca. 2.0-4.0 μm in length), however, the few detailed karyological studies (e.g., Lee 1985) lack the detail to infer mechanisms of chromosomal evolution, although these chromosome numbers indicate the prevalence of polyploidy and/or aneuploid variation of the prospective basic number. The validation of $2n = 22$ for *T. nuttallii* strengthens support for the monophyly of *Toxicoscordion*, as well as the phylogenetic significance of chromosome numbers as generic synapomorphies for tribe Melanthieae.

ACKNOWLEDGMENTS

Jason Spangler and Tom Wendt (TEX) generously provided live bulbs of *T. nuttallii* collected in the field. David E. Giannasi contributed his expertise with the laboratory work, kindly shared reagents and equipment, and also reviewed a draft of the manuscript. I am grateful also to Michael Boyd and Andrew W. Tull (Plant Biology Dept. Greenhouse Facility, University of Georgia) for reviving and maintaining plants shipped from the field; Walter S. Judd and Dale E. McNeal for editorial comments; Emily Wood for assistance at GH; Robert J. Liebermann for translating Russian text; James L. Zarucchi for providing a copy of the in-press *Zigadenus* treatment from the *Flora of North America*; and William Carromero for the Spanish translation of the abstract. Funds provided by the University of Georgia Department of Plant Biology financed laboratory materials.

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A COMMUNITY-LEVEL FLORISTIC RECONNAISSANCE OF THE RAJA AMPAT ISLANDS IN NEW GUINEA

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ABSTRACT

The Raja Ampat district of Indonesian Papua is one of New Guinea's most unusual floristic environments. A recent rapid-assessment survey examined vegetation patterns across the district, characterizing the major plant communities and identifying existing biodiversity threats. Mangroves, beach forest, lowland hill forest, limestone karst, and ultrabasic (serpentine) woodland were the principal natural-growth habitats explored by the botanical team. Although several lowland areas are being degraded by concessional logging, most of the limestone communities remain in pristine condition. There are substantial prospects for future taxonomic discovery.

KEY WORDS: botanical survey, limestone karst, Papua, serpentine, ultrabasics

ABSTRACT

インドネシア領パプアのラヤアンパット地域はニューギニアの最も特徴ある植生地域の一つである。最近のラピッドアセスメント調査において、地域の植生パターン、植物群落の特徴、存在する生物多様性破壊の危機について調べられた。マングローブ林、海岸林、低地丘陵林、石灰岩カルスト、超塩基性土壌（蛇紋岩）林が今回調査を行った主な自然植生帯である。幾つかの低地林は商業伐採による植生の撹乱が見られたが、殆どの石灰岩土壌地域は原植生の状態を保っており、分類学上の価値ある発見がされる可能性が高いと思われる。

キーワード：植生調査、石灰岩カルスト、パプア、蛇紋岩、超塩基性土壌

INTRODUCTION

Located at the far western end of New Guinea, the Raja Ampat islands (Figs. 1, 2) are one of Malesia's little-known environmental jewels. In addition to spectacular coastal vistas deserving of World Heritage recognition, recent studies have determined that the islands probably have the highest levels of coral and reef fish diversity in the world (Reefbase 2002). Floristically, the Raja Ampat contain 3 of the 22 Papuan areas recognized as centers of very high endemism (Supriatna 1999).

Most of western New Guinea (including Misool and northern Salawati) are

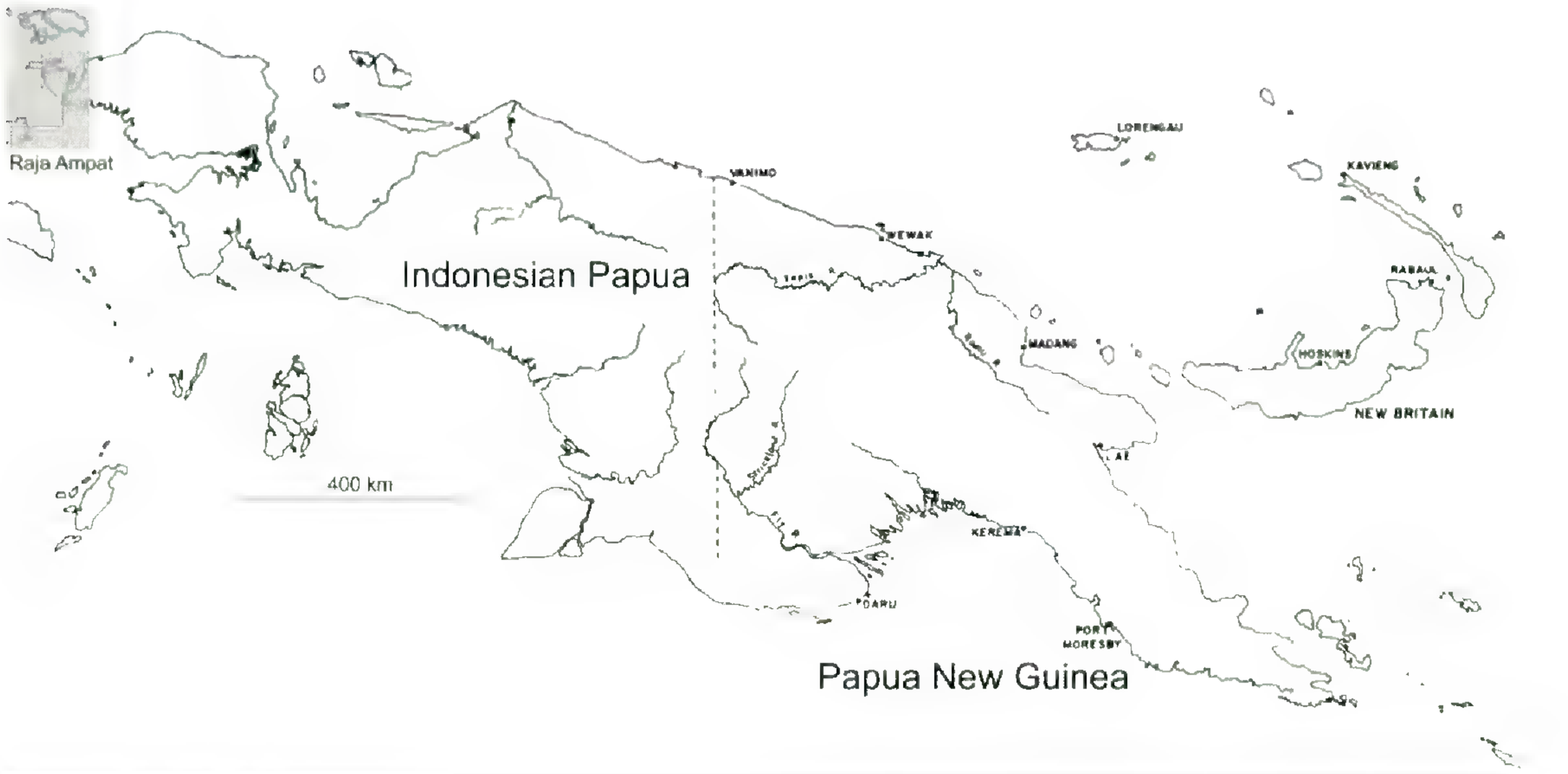


Fig. 1. Island of New Guinea. Shaded area: Raja Ampat district.

part of a Papuan microcontinent which separated from the Gondwanic landmass during the early Mesozoic, subsequently drifting into its present position independently of the Australian craton (Pigram & Panggabean 1984; Pigram & Davies 1987; Hall 1998). Waigeo and adjacent islands comprise one of only two oceanic terranes in this region of New Guinea. Especially in the westernmost islands, ultrabasic and limestone substrates have developed distinctive plant communities containing many endemic species.

Ironically, considering the overall paucity of information for such environments, the Raja Ampat was among the first areas to be visited by early explorer-naturalists to eastern Malesia. In 1792–93, the vessels *Recherche* and *Esperance* obtained plant collections from Waigeo as part of a general program of regional exploration. Botanical specimens were also taken during visits by the *Uranie* and *Physicienne* in 1818–19, and during the cruise of the *Astrolabe* (1826–29). Early collectors included Beccari (1872–73) on Batanta and Kofiau, and Micholitz in 1890, also on Batanta. Frodin and Gressitt (1982) provide a general account of these early activities. Following the efforts of Cheesman on Waigeo (1938–39) and by Royen on Batanta and Waigeo (Royen 1960), there was little serious work in the district. Most of the interior sections remain unknown because of the physical difficulties of access and the nearly total absence of service infrastructures.

MATERIALS AND METHODS

The Nature Conservancy (TNC) survey of the Raja Ampat was designed primarily to investigate the diverse reef ecosystems of the area, and secondarily to identify linked land-marine conservation targets for possible community-based initiatives. During a 3-week period (Oct. 30 to Nov. 22, 2002) the scientific team

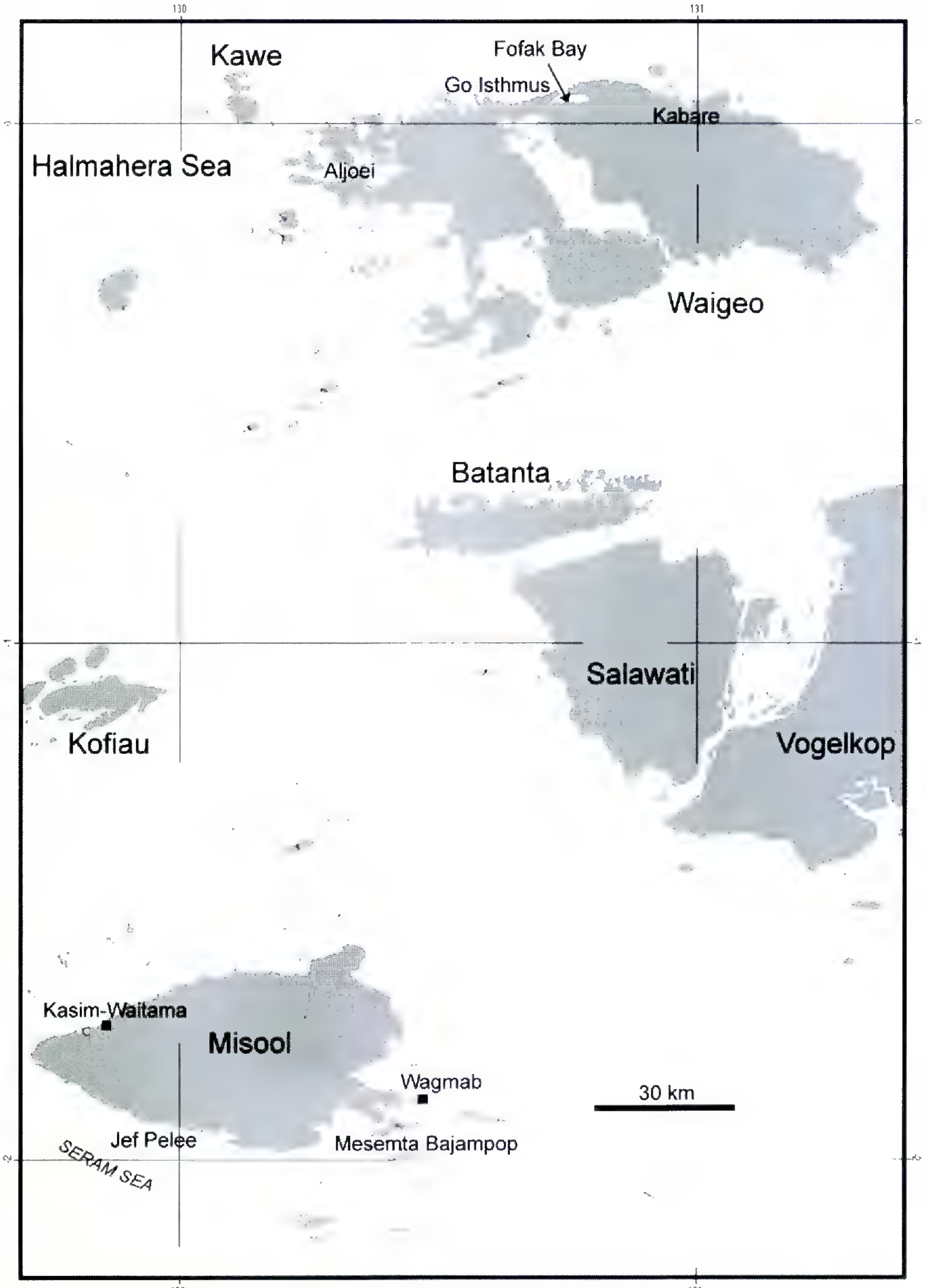


FIG. 2. Raja Ampat District. Principal localities from the TNC biological reconnaissance. Sayang and Wayag islands are (respectively) 35 and 17 km NW of Kawe and outside the map boundaries.

made numerous stopovers among all the main islands, using a chartered diving vessel (the *Pindito*) as a live-aboard mobile base. As ecologist for the forest assessment, the writer was responsible for describing the principal vegetation types and ground-truthing perceived community distributions against a preliminary classification developed from the RePPProT (Regional Physical Planning Program for Transmigration) plant typology maps (RePPProT 1990; Hardiono 2002). The floristic evaluations and botanical collecting were conducted with assistance by Duncan Neville (TNC Sulawesi Manager), Johanis Mogea (Herbarium Bogoriense), and Fery Liuw (Departemen Kehutanan Papua).

Forest communities were examined in *ad hoc* fashion, via walk-through assessment of areas accessed by dinghy or speedboat (Figs. 3–5). Community variation was documented by numerous photographs referenced with readings from a handheld GPS recorder. These onshore activities were necessarily constrained by the collateral marine studies and the corresponding movements of the *Pindito*. Because of the constantly shifting itineraries of the marine team, the forest participants could usually devote only one day to a given site, thus restricting survey coverage to areas near the coast.

Botanical collections were typically made in sets of 5 duplicates whenever fertile specimens were found. Gatherings were field-packed in newsprint and plastic bags, then soaked with 70% ethanol for subsequent processing at Herbarium Bogoriense (BO). Silica-dried samples for DNA sequencing were also obtained if specialists had placed earlier requests for assistance. In order to simplify the vouchering process, collections were numbered under the sequence of botanist J. Mogea. Specimen distributions will occur from BO, with A, K, L, and MAN as the principal recipients (Irawati pers. comm.). A taxonomic account of the botanical findings is being prepared by Mogea for separate publication.

RESULTS

Botanical observation and collecting were complicated by drought conditions caused by the recent El Niño disturbance. The collections tally (550 nos.: Mogea et al. 7726–8276) includes about 100 sterile numbers because of the unfavorable phenology. Although the entire district showed signs of drought stress, the severity of the disturbance was greatest in the outer islands (Misool, Kawe, and Waigeo; Fig. 6). At Batanta and Salawati, forest canopies were mostly green (although understories were very dry) and there were even brief periods of torrential rain during the visit to those islands.

Among the habitats covered by the TNC-modified RePPProT forest classification, mangroves were apparently the only natural-growth community which could be accurately mapped using Landsat reflectance patterns (see Hardiono 2002). Topographic and geological maps proved of greater value than any existing forest typing system. The lack of a GIS-based classification equivalent to the Papua New Guinea Resource Information System (PNGRIS) and its



Fig. 3. Land team members (Duncan Neville and Fery Liuw) boarding a zodiac after surveying an island in the Jef Pelee group. The 75–ft Pindito lies anchored offshore. Zodiac and speedboat tenders provided daily transport for the land-sea survey. Photo November 9, 2002.

Fig. 4. For travel over longer distances, the team used a speedboat ('longboat') of a versatile design widely employed in the Papuan coastal and riverine traffic. Despite their unwieldy appearance the shallow-draft longboats are capable of entering the headwaters of even small streams. A survey longboat is shown here at Wagmab Island. Photo November 4, 2002.

Fig. 5. Wagmab Island, SE Misool. Forester Fery Liuw searches for botanical specimens in the dry scrub on limestone talus. In spite of exemplary support logistics, collections were few and difficult to obtain because of the unfavorable conditions. Photo November 4, 2002.



Fig. 6. Kawe. Drought-stricken serpentine woodland on steep slopes. Photo November 18, 2002.

generically related Forest Inventory Mapping System (FIMS), is a serious obstacle to survey planning in western New Guinea (see Bellamy & McAlpine 1995; Hammermaster & Saunders 1995a, b). To facilitate comparisons with the FIMS classification, the following community descriptions are prefaced by the structural code (in parentheses) for the corresponding formations in East New Guinea.

The expedition included 15 fulltime participants, of which 5 were journalists or photographers. As a result of the intensive media coverage, survey images and preliminary findings are available on several websites (http://www.reefbase.org/RajaAmpat/; http://www.AliensOfTheSea.com/HDTV; http://www.projectbirdwatch.org/rajaampatrea/).

Principal Communities

Mangroves.—(M) Of all the vegetation types encountered on the survey, the mangrove communities are probably the best-studied (e.g. Backer & Steenis 1951; Ding Hou 1957, 1958, 1960; Percival & Womersley 1975; Floyd 1977; Duke & Jackes 1987; Erftemeijer et al. 1989; Duke 1991; Mabberley et al. 1995). Unlike the situation in nearby Telek Bintuni (cf. Erftemeijer et al. 1989; Takeuchi et al. in press), Raja Ampat mangroves are insignificant and markedly impoverished, except in a few places where estuarine flats and tidal rivers have provided ample habitat for the *Bruguiera-Rhizophora* associations (Fig. 7). Among investigated



FIG. 7. Wayag Island. Interior view of a mangrove forest on limestone karst. Trees are represented mostly by *Bruguiera gymnorrhiza* and *Rhizophora mucronata*. Photo November 16, 2002.

sites, the best examples of this community were seen on Pulau Misool, along the lower Gam and Kasim rivers. At the second locality, there is a well-developed upstream sequence (in order) of *Rhizophora mucronata – Ceriops tagal*, *Bruguiera gymnorrhiza*, *Nypa fruticans*, then a final freshwater assemblage consisting of *Xylocarpus granatum*, *Dolichandrone spathacea*, and *Heritiera littoralis*. However in most parts of the archipelago, mangroves are represented (if at all) only by isolated trees along a foreshore, with no horizontal development of the community.

Swamp woodland.—(Wsw) Monodominant forests of *Metroxylon sagu* (sago) are scattered through the Raja Ampat district, wherever soil flooding is severe. The occurrences are insensitive to substrate. Sago swamps are found on limestone at Kofiau (01°09'25S, 129°51'38E), and on mineral clays at Kapatlap, Salawati. Although the floristic diversity is very low, sago communities are of considerable subsistence value as a source of dietary starch obtained from the *Metroxylon* trunks (cf. Powell 1976; Johns & Hay 1984).

Littoral or beach forest.—(B) A distinctive community along many coastlines, beach forests are mostly composed of widely distributed, even pantropical taxa, but have been reduced over much of their former range because of anthropogenic pressures (Wikramanayake et al. 2001). The principal indicator species for this community are *Calophyllum inophyllum*, *Hibiscus tiliaceus*,



Fig. 8. Open beach forest on Wagmab. In the western Raja Ampat, mangroves and beach forest are generally scarce. The limestone and serpentine vegetation often extend to the highwater line, displacing the beachfront communities more characteristic of other coastal areas. Photo November 4, 2002.

Pandanus tectorius sens. lat., *Terminalia catappa*, and *Thespesia populnea* (Fig. 8). In the Raja Ampat other associates often included *Colubrina asiatica*, *Parsonsia alboflavescens*, *Derris indica* (*Pongamia pinnata*), *Tacca leontopetaloides*, *Ximenia americana* var. *americana*, and *Vigna marina*. Beach forest generally occurs on sand or coralline rubble behind the strand zone. A particularly good example was seen at N Kofiau (01°09'24S, 129°50'47E). On uninhabited Sayang Island (0°16'24S, 129°53'47E), a different type of beach association (BCe) was recorded on sandy flats, consisting of *Casuarina equisetifolia*, *Scaevola sericea*, *Sophora tomentosa* ssp. *tomentosa*, *Spinifex littoreus*, and *Tournefortia argentea*.

Lowland forest on deep mineralized soil.—(Pl, Hm) The land team encountered this community type near Kapatlap on Salawati, and on the north and south shores of Batanta, where the vegetation is predominantly a tall stature rainforest similar to those from coastal lowlands of the Bomberai Peninsula. Deep soil habitats (in the eastern Raja Ampat) were probably the most speciose of all the surveyed environments, but were also characterized by plants common in adjacent mainland areas and thus of comparatively low conservation interest (Figs. 9, 10). *Intsia bijuga*, *Koordersiodendron pinnatum*, *Pometia pinnata*, and *Terminalia* cf. *copelandii* were dominant trees in such situations, with *Celtis*, *Ficus*, *Dysoxylum*, *Myristica*, and *Syzygium* the best-represented genera in the subcanopy. The regrowth phase included *Alstonia scholaris*, *Gastonia serratifolia*, *Morinda citrifolia*, and *Trema cannabina* as the most prominent species, at least within the logged-over tracts seen on Batanta and Misool.

In the western Raja Ampat, deep soil habitats are generally absent except in the flood plain of large rivers (e.g. Gam and Kasim rivers), or in the ravines on limestone karst (e.g. the numerous islets near Mesemta Bajampop of SE Misool). Such areas have tall forests comparable to the Batanta/Salawati formations, but are species-poor and usually less than 1 ha in size (Figs. 11–13). Frequently, the stands are composed of *Intsia bijuga*, *I. palembanica*, *Vatica rassak*, or *Pometia pinnata*; with *Jagera javanica* ssp. *javanica*, *Trophis philippinensis*, *Teijsmanniodendron bogoriense* (uncommon), and *Maniltoa* spp. (*M. plurijuga* and *M. schefferi*) underneath. *Flindersia amboinensis* and *F. laevigata* var. *heterophylla* are conspicuous emergents in these tall-forest pockets on the smaller islands, particularly in the Misool group. *Osmoxylon sessiliflorum* was especially prominent in subcanopies near rivers (Misool). At Jef Pelee (S. Misool) a *Homalium foetidum* monodominant forest was encountered on ridge slopes and crests (Figs. 14, 15; 02°01'09S, 130°01'28E).

The forest understories in the Raja Ampat are harder to characterize. Generally when the canopy has at least 25–50% closure the groundlayer is already clear. Representative communities in the Misool group had either an open understory, or a palm-dominant layer of *Licuala* and rosette-stage *Calamus* (Figs.







Fig. 9. Forest understory on south Batanta, generally species-rich in comparison to the outer Raja Ampat. Photo November 3, 2002.

Fig. 10. Batanta. Lowland coastal forest on deep soils, in the process of conversion to subsistence gardens. Tall canopies (>30 m height) are common on islands close to the New Guinea mainland (i.e. Batanta and Salawati) but are essentially absent on the outer islands. Photo November 3, 2002.

Fig. 11. Wagmab. Forest in broad ravine. Communities are denser, taller, and richer than the surrounding vegetation on higher slopes. Photo November 4, 2002.



Fig. 12. Interior view of the forest shown in Fig. 11. Photo November 4, 2002.

Fig. 13. Alluvial forest along the Kasim River of western Misool. Photo November 10, 2002.

Fig. 14. Misool. Interior perspective of a *Homalium foetidum*-dominant forest on ridgecrests. Photo November 9, 2002.



Fig. 15. As for preceding figure. Showing the canopy closure and crown density. Photo November 9, 2002.



FIG. 16. Misool. Understory of a limestone forest. The near-ground interval is generally clear or with scattered palms. Photo November 4, 2002.

16, 17). Ferns, herbs, and cryptogams were hardly ever seen, but it is not known to what extent their absence was due to the severe drought conditions then prevailing. Understories with diverse fern populations (*Bolbitis, Davallia, Drynaria, Nephrolepis, Sphaerostephanos, Tectaria*) were found only in riverine forest near Fanfanlap (W Misool) and at Kofiau (e.g. 01°10'01S, 129°50'30E).

Secondary forests.—(W) A substantial but unknown percentage of the Raja Ampat lowlands has been logged by industrial operators and is presently in various stages of recovery. The secondary forests examined by survey were previously cut at periods ranging from 15 to 30 years ago and are very distinct from more mature communities in the same habitat.

At Kofiau (01°11'03S, 129°43'21E) a 15–year regrowth (Figs. 18, 19) was a depauperate woodland of *Vitex cofassus, Morinda citrifolia, Conandrium polyanthum*, and *Ficus* spp. (mainly *F. microcarpa* and *F. prasinocarpa*). *Lunasia amara* var. *amara, Leea indica*, and various *Antidesma* and *Macaranga* spp. formed a sparse underlayer. In contrast, an adjacent section of unlogged forest was a closed canopy *Pometia*-dominant community with high frequencies of *Diospyros, Horsfieldia*, and *Knema*.

On Sayang (a flat sandy island completely logged in 1984; 0°16'38N, 129°53'48E), the regrowth was of similarly depleted composition, consisting for the most part of a remnant *Artocarpus-Intsia-Pometia* canopy with a second



Fig. 17. Kawe. Characteristic appearance of an understory from serpentine stands in ravines and valleys. Stems are generally of small diameter and herbaceous growth is sparse. The ground layer often has seedling crops of the canopy taxa. Ferns and gingers are conspicuously absent. Photo November 18, 2002.





FIGS. 18 and 19. Kofiau. Regrowth community from a former forest clearfelled 15 years ago. Photo November 12, 2002.

story of *Calophyllum inophyllum* and *Aglaia argentea* (the last species previously unrecorded for the Raja Ampat, cf. Pannell 1992). *Conandrium polyanthum*, *Codiaeum variegatum* var. *moluccanum*, and *Polyscias cumingiana* were undergrowth species. Dense seedling crops of *Pometia pinnata* often carpeted the ground in spite of drought conditions.

On a number of small islands, repeated anthropogenic disturbances have erased the former forest and a grassy fire disclimax (G) is now all that exists. At Jef Pelee (coral platform: 02°07'03S, 130°19'00E) most of the land surface is covered by a seral community of *Imperata conferta* with *Ischaemum muticum* on the seaward fringe (Fig. 20).

At Mesemta Bajampop a single example was seen of an early succession on karst, consisting of *Dracaena angustifolia* and *Commersonia bartramia*, with an extensive underlayer of *Gahnia aspera* (Fig. 21).[1]

Savanna.—(SaMl) Grassy savannas were recorded only on W Misool, at the mouth of the Kasim River and further inland near the Waitama tributary (01°47'23S, 129°53'57E and 01°51'41S, 129°55'05E respectively). The Kasim com-

[1]These sort of communities are the result of localized disturbance and are too small to be mapped by forest classification systems.



Fig. 20. Jef Pelee. Anthropogenic sedge-grassland (*Imperata-Ischaemum-Scleria*) on limestone islands near the Misool mainland. Other seral taxa included *Desmodium umbellatum*, *Premna serratifolia*, *Morinda citrifolia*, and *Pandanus tectorius*. Photo November 8, 2002.



Fig. 21. Mesemta Bajampop. A seral community on karst, consisting exclusively of *Commersonia bartramia*, *Dracaena angustifolia*, and *Gahnia aspera*. Photo November 5, 2002.

munities were *Melaleuca* dominant, but also included smaller individuals of *Pandanus tectorius* and *Timonius timon* in a distinct second layer (Figs. 22, 23). The dense 2 m+ groundcover was composed of *Ischaemum barbatum* and *Imperata conferta*, together with scattered patches of taller *Saccharum spontaneum* (Fig. 24). Indications of recent burn suggest that the Kasim savanna is probably periodically fired.

The Waitama savannas are larger than the Kasim communities and include *Eucalyptus* cf. *papuana* in addition to the more common *Melaleuca leucadendron* sens. lat. (Fig. 25). Shrubs were commonly represented by *Baeckea frutescens*, *Decaspermum bracteatum*, *Melastoma malabathricum* ssp. *malabathricum*, and a *Polyscias* sp. The groundlayer of *Ischaemum barbatum* and *Rhynchospora rubra* was habitat-partitioned, the latter species mainly occupying flat areas with the poorest drainage.

In appearance and composition the Waitama savannas are nearly identical to comparable formations on the Papuan mainland at Bomberai (cf. Takeuchi et al. in press). The communities at both sites are apparently under substrate control, with characteristic occurrences on flat or gently undulating terrain underlain by hardpan and alumina deposits (pers. obs.). Although the savannas in the Raja Ampat are affected to some degree by fire, the substrate patterns suggest the communities are a longterm response to stable edaphic factors (cf. Paijmans 1976).

Lowland forest on limestone karst.—(Hs, HsCp)[2] The limestone terrain is one of the most visually stunning and unspoiled environments in the Raja Ampat district. Much of this habitat is a deeply dissected karst which is often extremely difficult and time-consuming to traverse. A small hill can take an entire morning to ascend, so it is not hard to comprehend the relative lack of botanical collections from such areas.

Excellent examples of karst vegetation are found in the Misool chain, particularly in the SW complex of small islets and at the western end of the Misool mainland. Within the Waigeo group, extensive limestone habitats were explored near Aljoei (0°11'43S, 130°15'39E) and at Wayag (0°10'21N, 130°01'17E).

Many of the smaller limestone islands are undercut at the highwater line into toadstool platforms, or are sculpted into steep conical stacks (Fig. 26). Oftentimes the sides of the taller islands have dizzying vertical faces that plunge for hundreds of feet (Figs. 27, 28). On Wagmab, the stepped ledges have a stunted woody vegetation, frequently wind-sheared, comprised of *Stenocarpus moorei*, *Exocarpos latifolius*, *Polyscias* sp. nov., *Wikstroemia androsaemifolia*,

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[2]The FIMS code is partly based on the dominance of *Gymnostoma papuanum* (=*Casuarina papuana*) which is replaced by *Gymnostoma rumphianum* (=*Casuarina rumphiana*) in the Raja Ampat. The second species is a relatively minor element in the limestone flora but a conspicuous emergent on ultrabasics. In conformity with FIMS convention, the Raja Ampat code would be rendered as 'HsCr', or 'HsGr' in any extension of the typing system to Western New Guinea.



FIG. 22. Misool. *Melaleuca leucadendron* s.l., the dominant stand-forming species in the Raja Ampat savannas. The whitish-papery outer bark and drooping leaves are characteristic. Photo November 10, 2002.



FIG. 23. Misool. Kasim river savanna. *Timonius timon* forms a second, darker-leaved layer beneath taller *Melaleuca*. Photo November 10, 2002.



FIG. 24. As for Fig. 23. The grassy groundcover of *Ischaemum barbatum* and *Imperata conferta* is typical. Photo November 10, 2002.



Fig. 25. Misool. The large savanna complex at Waitama. Photo November 11, 2002.



Fig. 26. Aljoei. Steep sided stacks and platforms, a typical geomorphic feature of the limestone terrain at Misool and Waigeo. Photo November 14, 2002.



FIG. 27. Aljoei. Limestone cliffs. Labyrinthine submarine caves are present along many of the underwater walls. Photo November 14, 2002.

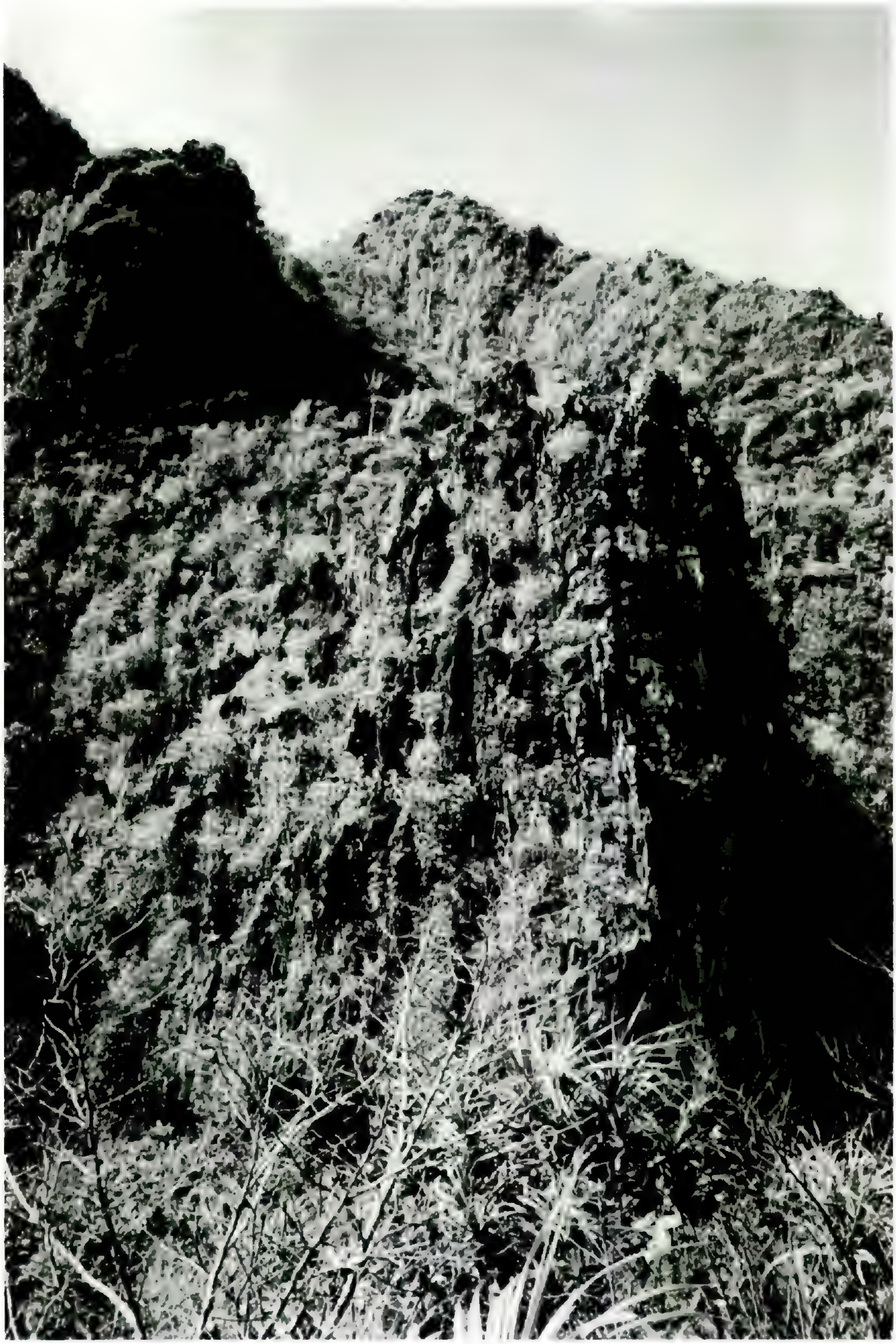


Fig. 28. Limestone precipices on Wagmab. Photo November 4, 2002.

Calophyllum spp. (including the *novoguineense* complex; cf. Stevens 1995), and many vines of *Alyxia purpureoclada* (Fig. 29). The unusual *Podocarpus polystachyus* is a dwarfed *krummholz* on solid rock, sprawling across ledges and barely ascending to 1 m height. But at Wayag, crestline populations of the same species grow as erect trees to 7 m height (Fig. 30; 0°10'25N, 130°01'22E and 0°10'42N, 130°01'16E).

On nearly all the limestone islands, *Gulubia costata* is a conspicuous emergent, often forming dense stands along the higher slopes and crestlines. *Barringtonia*, *Dracaena*, *Ficus*, *Garcinia*, *Gynotroches*, *Myrsine* (*Rapanea*), *Pouteria* (*Planchonella*), *Schefflera*, *Serianthes*, and *Sterculia* are also common subarborescent genera, but a disproportionate number of morphospecies were documented only by sterile or scrappy vouchers and cannot be identified with certainty. Of all the Raja Ampat habitats, the limestone vegetation was the most severely affected by the El Niño drought, and effective documentation of such communities was very difficult under the prevailing conditions. The canopies on most islands were brown and withered, though probably not dead. Limestone karst is undoubtedly a poor reservoir for soil moisture. Especially on small islands, stands with green foliage were often restricted to the colluvial accumulations in valleys and small draws (Figs. 11, 12).

Archidendron paluense, *Lunasia amara* var. *amara*, and the vinelike *Bauhinia binata* (*Lysiphyllum binatum*) were common taxa in karst understories of the western Raja Ampat, especially on platforms and stacks around Misool proper. At Mesemta Bajampop, substantial populations of *Rauvolfia moluccana* and *Monophyllaea* were also noted. The *Archidendron*, *Bauhinia*, *Monophyllaea*, and *Rauvolfia* were newly recorded for the district (cf. Burtt 1978; Verdcourt 1979; Nielsen et al. 1984; Hendrian & Middleton 1999). New registers for such common or conspicuous plants are indications of the undercollected status of the limestone, and show how poorly documented this flora still remains even after more than a century of Papuan exploration.

Lowland ultrabasic scrub and forest.—(W, HsCp) Renowned in scientific literature, the Raja Ampat serpentine flora is also one of the region's most picturesque environments. At Kawe (Figs. 31, 32) and Waigeo's north shore (Fig. 33) the ultrabasic scrub affords breathtaking panoramas of turquoise reefs and red laterite across extensive stretches of coastline.

The TNC survey explored the ultrabasic zone in a series of ascents along steep-sided buttress ridges. Most of the vegetation consisted of xeromorphic scrub or woodland with similar characteristics to communities described in an earlier account of the eastern Waigeo peninsula (Royen 1960).

During the first landfalls on Kawe (ending at 0°03'07S, 130°08'05E), the forest team found a distinctive woodland of *Ploiarium sessile*, *Exocarpos latifolius*, *Gymnostoma rumphianum*, *Decaspermum bracteatum*, *Ixonanthes reticulata*, and *Myrsine rawacensis* (Fig. 34). The spreading sympodial crowns of *Ploiarium*



Fig. 29. Wagmab. Vegetation on limestone ledges. Photo November 4, 2002.

sessile were a particularly striking characteristic of this community (Fig. 35). In the wide spaces between the larger trees were many shrubs of *Myrtella beccarii*, *Styphelia abnormis* and (in lesser numbers) *Dodonaea viscosa*. Vines of *Alyxia laurina* were common climbers and scramblers. Patches of *Dicranopteris linearis* blanketed the ground nearly everywhere, with *Dianella ensifolia*, *Nepenthes danseri*, *Palhinhaea cernua*, *Machaerina disticha*, and *M. glomerata* scattered mainly over the bare spaces. *Artocarpus*, *Livistona*, and *Vitex* were common on lower slopes and valley floors (Fig. 36; 0°03'05S, 130°08'24E).

On the Go Isthmus of Waigeo (Fofak Bay at 0°02'22S, 130°43'43E), the ultrabasics were similar though somewhat richer, and also included *Arytera littoralis*, a small-leaved *Gmelina*, *Melastoma malabathricum* ssp. *malabathricum*, *Psychotria tripedunculata* (Fig. 37), and *Rhodamnia novoguineensis* among the common woody plants. Parts of the scrubland above the bay had been burned, exposing large patches of the distinctive red laterite (Fig. 38). Within such areas, the early fire succession consisted of a sparse association of *Commersonia bartramia*, *Myrtella beccarii*, *Scaevola oppositifolia*, and *Styphelia abnormis*. Although the ridgetop habitats are generally of open aspect, the vegetation in the draws is a closed codominant forest of *Dillenia alata* and *Calophyllum* spp. At scattered places in the ultrabasic zone (on both crestlines and depressional areas), the scrub is replaced by a taller *Gymnostoma rumphianum*-Sapindaceous



FIG. 30. Wayag. *Podocarpus polystachyus* (5–7 m tall), a common limestone species. Photo November 16, 2002.



Fig. 31. East-central coastline of Kawe island, an ultrabasic outcrop 15 km west of Waigeo. In contrast to the uneven and deeply dissected limestone, ultrabasics are characteristically composed of massive ridges with uniform slopes (Löffler 1977). Photo November 18, 2002.



FIG. 32. Kawe. Three-shot montage (moving N to ESE: top frame to bottom frame) of ultrabasic woodland near the summit. The equator passes slightly to the right of the small island in the near background (center photo). Western Waigeo is on the horizon of the last frame (to ESE). Photo November 17, 2002.



Fig. 33. Waigeo ultrabasic scrub at the entrance of Fofak Bay. Center of view to the southeast, showing the irregular outline of limestone karst against the skyline (compare Fig. 31 Kawe island). Foreground: the sympodial architecture of *Ploiarium sessile* is the most distinctive feature of the open community. *Dicranopteris linearis* forms the groundlayer. Photo November 19, 2002.



FIG. 34. *Myrsine rawacensis* on Kawe ultrabasics. Photo November 17, 2002.



FIG. 35. *Ploiarium sessile*, the dominant woody plant in the ultrabasic scrub. Obtuse leaves and sessile flowers immediately distinguish this species from congeners (Kobuski 1950). Originally recorded from Halmahera (ibid.), *P. sessile* is still known from only a few collections. Photo November 17, 2002.

canopy with a *Myrtella beccarii* understory (e.g. at Kabare, 0°04'18S, 130°56'36E; Figs. 39, 40). Unlike the open growth, this taller community (at Kabare) is densely stocked with 7–10 m pole-trees including the serpentine indicator *Ploiarium sessile*. *Gymnostoma rumphianum* is a 25 m emergent in such situations. The ultrabasic vegetation is thus represented by several communities, collectively forming an intergrading series of facies ranging from bare 'blow-outs' (Fig. 41) through woodland of varying densities, then finally to a closed multistoried forest.

DISCUSSION

Raja Ampat plant communities are primarily lowland environments. There are no areas of significant size higher than the 900–1000 m level where montane conditions generally begin (cf. Paijmans 1975, 1976; Johns 1977; Grubb & Stevens 1985; Hammermaster & Saunders 1995a). Although Royen (1960) describes a mossy montane forest on Mt Buffelhoorn, such habitats could not be visited within the time allowed by the survey schedule. None of the daily excursions from the coast were able to penetrate beyond 500 m elevation.

Within the limitations imposed by rapid assessment, it is apparent that



FIG. 36. Serpentine bedrock in a large V-valley of south-central Kawe. In spite of the drought, a spring-fed creek flowed for several hundred meters over waterfalls in the middle valley, before disappearing into crevices along the streambed. A locally-luxuriant vegetation flourished along the banks, with dry woodland (Fig. 6) covering the higher slopes. No aquatic life was present other than small shrimp. Photo November 18, 2002.







Fig. 37. The aptly-named *Psychotria tripedunculata*, one of the most common shrubs on the ultrabasics. Photo November 19, 2002.

Fig. 38. Waigeo fire successional community. Burning removes the normal groundlayer of *Dicranopteris linearis* and *Machaerina glomerata*, leaving mainly scattered shrubs of *Commersonia bartramia*. Photo November 19, 2002.

Fig. 39. A closed stand of pole-stemmed trees near the fire succession shown in Fig. 38. The ultrabasic forest facies is connected to the open vegetation by a continuum of transitional communities. Photo November 19, 2002.



FIG. 40. Ultrabasic forest at Kabare. Showing the closed structure of the presumably older growth, often *Gymnostoma-Myrtella* codominant. Photo November 20, 2002.



FIG. 41. Waigeo blowout. Large patches of sheet-eroded earth are scattered through the scrubland, exposing the distinctive orange-red laterite of the ultrabasic zone. These erosional features are probably a recent result of forest removal. Although the open communities convey an impression of stability and continuity, the development of such areas is actually part of a historical pattern of ecological degradation. Photo November 19, 2002.

the Raja Ampat flora is depauperate and disharmonic relative to adjacent mainland environments and that these distinctions become more pronounced in the outer island groups (e.g. Misool and Waigeo). Many of the most characteristic Papuasian families, including Annonaceae, Elaeocarpaceae, Gesneriaceae, Lauraceae, Melastomataceae, Meliaceae, Piperaceae, and Urticaceae, were poorly represented in the lowland habitats where they are ordinarily prominent. Epiphytes and climbers were also generally scarce, as were several herbaceous families usually found in New Guinea forest understories (e.g. Marantaceae, Orchidaceae, Zingiberaceae).

This westward trend of diminishing diversity across the archipelago is correlated to a general reduction in rainfall and to the limiting nature of the western substrates. Rainfall is directly correlated with floristic diversity, more than with any other abiotic factor (Gentry 1988). The perception of highest richness in the near-mainland environments of Salawati and Batanta, and the impression of lower species counts toward the outer groups, is consistent with annual rainfalls (cf. Mangen 1993): Salawati and Batanta (3000–3500 mm); Misool (2500–3000 mm); Waigeo and adjacent islands (1500–2000 mm). The floristic trends expected from moisture availability are enhanced by the substrate dis-



FIG. 42. Kamiali, Papua New Guinea. Successional scrub community on a 15-year old landslide. Plants on the exposed ground include *Myrtella beccarii*, *Stenocarpus moorei*, *Dicranopteris linearis*, *Machaerina glomerata*, and *M. rubiginosa*. The dominance of Cyperaceae (particularly *Machaerina*) is a curious feature of the ground layer in situations where grasses would ordinarily dominate on conventional substrates. This same pattern occurs on Waigeo serpentine. Photo Feb. 5, 2003.



FIG. 43. Kamiali, Papua New Guinea. Serpentine woodland dominated by *Gymnostoma papuana*, *Weinmannia fraxinea*, and *Tristaniopsis macrosperma* in the canopy, and by *Dicranopteris linearis* and *Myrtella beccarii* in the understory. Kamiali has about twice the rainfall of Waigeo, resulting in a denser and more diverse vegetation. Many species are common to both districts. Photo October 6, 2002.

tinctions. Whereas most edaphic environments in the eastern islands are of mineralized soil, the outer islands are predominantly limestone or ultrabasics, infertile substrates that are known to be limiting for plant growth (Royen 1963; Kruckeberg 1985; Brooks 1987). The synergistic combination of factors results in diminished richness but increased endemism.

In terms of exploration priorities, the highest potential for taxonomic discovery is probably with the Misool karst. Waigeo ultrabasics are comparatively easy to access and the communities are usually of low stature and density, characteristics which favor collection saturation. Most, if not all, of the ultrabasic endemics have probably been discovered. In contrast, the Misool limestone is wetter (notwithstanding conditions during the survey), very difficult to traverse, and suitable collections are much harder to find. A significant number of unknown taxa is likely to be present on the karst. The new distributional records from the survey are suggestive of future opportunities.

Conservation Assets.—When judged on the basis of uniqueness, the ultrabasic and limestone vegetation are the highest-value communities in the Raja Ampat. As presently known, the ultrabasics have more species endemic to its habitats than any of the other communities. Plants restricted to Waigeo ser-



FIG. 44. Peninsula at mouth of Fofak Bay, Waigeo. Inland view to the north (opposite the perspective in Fig. 33). Mapped as a *Gymnostoma* (*Casuarina*) forest in 1955, this area is now an eroded and depauperate scrubland. A few relictual emergents of *Gymnostoma rumphiana* are visible in the far distance, apparently all which remains of the former forest. Photo November 19, 2002.

pentine include *Alstonia beatricis*, *Alyxia laurina*, *Archidendron royenii*, *Guioa waigeoensis*, and *Maesa rheophytica*. *Psychotria tripedunculata* is also known primarily from the ultrabasics, with only one record originating elsewhere.

Waigeo's floristic patterns can be understood by comparison with similar areas from other districts in New Guinea. In the Bowutu Mts of Morobe Province, an elevational sequence of ultrabasic landscapes forms one of the largest features of this type in Papuasia (i.e. the Papuan Ultrabasic Belt, cf. Thompson & Fisher 1965; Bain 1973; Löffler 1977). Especially within the Kamiali Wildlife Management Area (KWMA), the serpentine flora extends across a series of coastal communities beginning at sealevel, in a manner analogous to Waigeo.

KWMA habitats are subject to frequent landslides because of a local combination of humid climate and steep coastal ridges. In the recovery following landslides, the community that develops is a scrub composed primarily of *Myrtella beccarii*, *Dicranopteris linearis*, *Machaerina glomerata*, and *M. rubiginosa*; with (at lesser frequencies) *Stenocarpus moorei* and *Tristaniopsis macrosperma* (Fig. 42). In appearance and composition, the pioneer community is very similar to the Waigeo scrubland and also occurs alongside a series of taller forests including many of the same elements (Fig. 43). The KWMA



FIG. 45. Mesemta Bajampop. Scenic limestone forests adjoining a sheltered reef teeming with marine life. Some of the highest coral counts during the survey were recorded from this reef, e.g. from the blue hole in the right frame (Turak, pers. comm.). Photo November 5, 2002.

community variation clearly represents a successional sequence, which can be tracked because of the known history of specific sites.

Royen (1960: 41) described the Waigeo scrub as an edaphic climax, but its spatial proximity and structural resemblance to other communities suggest otherwise. By analogy to similar environments, most of the Waigeo ultrabasics are probably an early stage in a successional sequence caused by fire. The principal characteristics of the open scrub are hardly different from landslide seres of the KWMA, except that the Waigeo communities are much larger, extending continuously over hundreds of hectares. The distinction in spatial scale can be attributed to the presumed fire etiology, which would tend to act over much larger areas than landslides. The etiologies can themselves be explained by the climatic contrasts between the sites. Fires are a common ecological factor in dry environments like Waigeo, while humid localities (KWMA rainfalls are 4000 mm per annum) are naturally susceptible to landslides during periods of heavy rain. Royen's own observations provide evidence of instability in the Raja Ampat ultrabasic vegetation (Royen 1960). The ridge in the foreground of Figs. 33 and 41 was a *Gymnostoma* (=*Casuarina*) forest in 1955 (ibid.: Fig. 5). As documented by the TNC survey, that forest now remains only as relictual trees surrounded by scrubland (Fig. 44). These open areas are clearly a new development and not a permanent edaphically-induced feature.

The frequent occurrence of fires is currently reflected in the patchy distributions of ultrabasic forest on Waigeo, an expected pattern if seral sequences are being continuously reset over large areas. Although the serpentine scrubland is one of Papuasia's most impressive environments, the rare and endemic taxa are concentrated in the taller vegetation, and this latter habitat probably represents a more valuable conservation asset. In an environment with fire-induced succession, the closed forest (Figs. 39, 40) should be the richest community, and thus the more promising target for future exploration.

Apart from the biotic measures, aesthetic considerations are a legitimate part of any environmental evaluation. Waigeo and Misool landscapes are very photogenic, and can serve as focal assets for an ecotourism niche market in combination with the marine attractions, as already demonstrated by the *Pindito* (www.pindito.com).

Ecosystem Threats.—During the last 50 years, the areas of post-fire succession in northern Waigeo have expanded substantially (compare Royen 1960: Figs. 3, 5). Several endemic plants are probably being threatened by the existence of this historical trend, particularly by the accompanying reductions of taller communities. Among ultrabasic species, *Archidendron royenii*, *Alstonia beatricis*, and *Maesa rheophytica* are still known only from their types, taken in primary forest or older-growth woodland (see Nielsen et al. 1984; Sidiyasa 1998; Sleumer 1987). From the circumstances of their collection, these plants are probably associated with the advanced stages of the ultrabasic succession,

and their apparent rarity is consistent with habitat reduction caused by increased fire frequency. In contrast, the ultrabasic endemics *Guioa waigeoensis* and *Alyxia laurina* are known by several collections from the open areas, and are probably seral taxa (cf. Welzen 1989; Middleton 2000).

Naturalized alien plants were not found on serpentine, or on most of the isolated karst islands at Aljoei and Mesemta Bajampop. Although limestone areas near human settlements often have a few adventives (viz. *Bidens pilosa*, *Boerhavia erecta*, *Euphorbia heterophylla*, *E. hirta*, *Passiflora foetida*, *Stachytarpheta jamaicensis*, *Tridax procumbens* etc.) truly invasive taxa were absent. The noxious *Lantana camara* and *Piper aduncum* were recorded only on Batanta and Salawati. The same factors which make the western environments limiting for plant growth apparently act to discourage the establishment of aliens.

A planted patch of *Hibiscus rosa-sinensis* was seen at uninhabited Wagmab, and even if such occurrences are not threatening, deliberate introductions into otherwise weed-free habitats need to be discouraged by proactive conservation policy. Predictive guidelines for assessing possible invasive success of alien plants have been developed for other island environments (cf. Pheloung et al. 1999; Daehler & Denslow 2002). Their application should be considered by Papuan managers administering conservation tracts, as most communities in the western Raja Ampat are of entirely indigenous or endemic composition. Nowadays, in a world where the spread of aggressive species contributes to homogenization of floras, areas such as the Misool karst are an increasingly rare ecological resource.

Each of the principal islands (Batanta, Misool, Salawati, Waigeo) have sizable set-aside areas designated as nature preserves (Supriatna 1999). However existing logging threats are substantial, and commercial operations were filmed during the recent TNC assessment even within the so-called reserves. Although the archipelago is known to have significant plant and faunal assets, many of these are under threat and will require management action to ensure their continuity (ibid.). Establishing new incentives for conservation will not be easy, since in most Raja Ampat forests the emergent canopy is composed of major exportable timbers (*Intsia bijuga*, *I. palembanica*, *Pometia pinnata*, *Flindersia amboinensis*, *Vatica rassak*; see Louman & Nicholls 1995) occurring at stocking densities which favor profitable extraction (Departemen Pertanian Direktorat 1977). Although the current concessional areas are habitats with good site capacities for tree growth, the ultrabasics and limestone karst have stunted vegetation of little value as logging targets, and are thus at lesser economic risk.

Despite indications that climatic warming will cause substantial reductions in Papuasia's rainforest biome, there have been no attempts to define local planning and management responses to this threat. Baselines are much needed for determining the onset and direction of climate-induced change in a variety

of communities. Because of their insular and pristine status, many Raja Ampat environments would make appropriate stations for monitoring the floristic effects of El Niño oscillations. The western islands are part of a forest continuum spatially connected to perhumid mainland habitats, extending across a geographic sequence of sparsely inhabited landscape, tectonic, and biotic environments. The district is very suitable as a venue for ecological research.

Nearly all conservation programs in New Guinea are committed exclusively to terrestrial or marine habitats, due to the disparate value of such environments when they occur together at most sites. However at Misool and Waigeo, highly endemic forest communities lie alongside some of the most diverse reef ecosystems in the world (Fig. 45). This unusual combination of worldclass assets will permit development of holistic strategies for managing the linked land-sea resources. The information needs for integrated planning will be complex, requiring data inputs on wildlife, floristic, recreational, cultural-political, landscape, and human subsistence values. But owing to the unique nature of the environmental assets in this district, future initiatives have the opportunity of being cost-effective, innovative, and compelling.

APPENDIX OF BINOMIALS CITED IN THE TEXT

Aglaia argentea Bl. (Meliaceae)
Alstonia beatricis Sidiyasa (Apocynaceae)
Alstonia scholaris (L.) R. Br. (Apocynaceae)
Alyxia laurina Gaudich. (Apocynaceae)
Alyxia purpureoclada Kaneh. & Hatus. (Apocynaceae)
Archidendron paluense (Kaneh.) Nielsen (Mimosaceae)
Archidendron royenii Kosterm. (Mimosaceae)
Arytera littoralis Bl. (Sapindaceae)
Baeckea frutescens L. (Myrtaceae)
Bauhinia binata Blanco (Caesalpiniaceae)
Bidens pilosa L. (Asteraceae)
Boerhavia erecta L. (Nyctaginaceae)
Bruguiera gymnorrhiza (L.) Lamk (Rhizophoraceae)
Calophyllum inophyllum L. (Clusiaceae)
Casuarina equisetifolia Forst. & Forst. f. (Casuarinaceae)
Casuarina papuana S. Moore (Casuarinaceae)
Casuarina rumphiana Miq. (Casuarinaceae)
Ceriops tagal (Perr.) C.B. Rob. (Rhizophoraceae)
Codiaeum variegatum (L.) Bl. var. *moluccanum* (Decne) Mueil. Arg. (Euphorbiaceae)
Colubrina asiatica Brogn. (Rhamnaceae)
Commersonia bartramia (L.) Merr. (Sterculiaceae)
Conandrium polyanthum (Laut. & K. Schum.) Mez (Myrsinaceae)
Decaspermum bracteatum (Roxb.) A.J. Scott (Myrtaceae)
Derris indica (Lam.) J.J. Bennett (Fabaceae)
Desmodium umbellatum (L.) DC. (Fabaceae)
Dianella ensifolia (L.) DC. (Liliaceae)
Dicranopteris linearis (Burm. f.) Underw. (Gleicheniaceae)
Dillenia alata (R. Br. ex DC.) Martelli (Dilleniaceae)
Dodonaea viscosa Jacq. (Sapindaceae)
Dolichandrone spathacea (L.f.) K. Schum. (Bignoniaceae)
Dracaena angustifolia Roxb. (Dracaenaceae)
Eucalyptus papuana White (Myrtaceae)
Euphorbia heterophylla L. (Euphorbiaceae)
Euphorbia hirta L. (Euphorbiaceae)
Exocarpos latifolius R. Br. (Santalaceae)
Ficus microcarpa L. (Moraceae)
Ficus prasinocarpa Elm. (Moraceae)
Flindersia amboinensis Poir. (Rutaceae)
Flindersia laevigata White & Francis var. *heterophylla* (Merr. & Perry) Hartley (Rutaceae)
Gahnia aspera (R. Br.) Spreng. (Cyperaceae)
Gastonia serratifolia (Miq.) Philipson (Araliaceae)

Guioa waigeoensis We.zen (Sapindaceae)
Gulubia costata Becc. (Arecaceae)
Gymnostoma papuanum (S. Moore) L.A.S. Johnson (Casuarinaceae)
Gymnostoma rumphianum (Miq.) L.A.S. Johnson (Casuarinaceae)
Heritiera littoralis Ait. (Sterculiaceae)
Hibiscus rosa-sinensis L. (Malvaceae)
Hibiscus tiliaceus L. (Malvaceae)
Homalium foetidum (Roxb.) Benth. (Flacourt:aceae)
Imperata conferta (Presl) Ohwi (Poaceae)
Intsia bijuga (Colebr.) O. Kuntze (Caesalpiniaceae)
Intsia palembanica Miq. (Caesalpiniaceae)
Ischaemum barbatum Retz. (Poaceae)
Ischaemum muticum L. (Poaceae)
Ixonanthes reticulata Jack (xonanthaceae)
Jagera javanica (Bl.) Bl. ex Kalkm. ssp. *javanica* (Sapindaceae)
Koordersiodendron pinnatum (Bl.) Merr. (Anacardiaceae)
Lantana camara L. (Verbenaceae)
Leea indica (Burm. f.) Merr. (Leeaceae)
Lunasia amara Blanco var. *amara* (Rutaceae)
Lysiphyllum binatum (Blanco) de Wit (Caesalpiniaceae)
Machaerina disticha (Clarke) Koyama (Cyperaceae)
Machaerina glomerata (Gaud.) Koyama (Cyperaceae)
Machaerina rubiginosa (Spreng.) Koyama (Cyperaceae)
Maesa rheophytica Sleumer (Myrsinaceae)
Maniltoa plurijuga Merr. & Perry (Caesalpiniaceae)
Maniltoa schefferi K. Schum. & Hollrung (Caesalpiniaceae)
Melaleuca leucadendron L. sens. lat. (Myrtaceae)
Melastoma malabathricum L. ssp. *malabathricum* (Melastomataceae)
Metroxylon sagu Rottb. (Arecaceae)
Morinda citrifolia L. (Rubiaceae)
Myrsine rawacensis A. DC. (Myrsinaceae)
Myrtella beccarii (F.v.M.) Diels (Myrtaceae)
Nepenthes danserii Jebb & Cheek (Nepenthaceae)
Nypa fruticans Wurmb (Arecaceae)
Osmoxylon sessiliflorum (Laut.) Philipson (Araliaceae)
Palhinhaea cernua (L.) Vasc. & Franco (Lycopodiaceae)
Pandanus tectorius Parkinson sens. lat. (Pandanaceae)
Parsonsia alboflavescens (Dennst.) Mabb. (Apocynaceae)
Passiflora foetida L. (Passifloraceae)
Piper aduncum L. (Piperaceae)
Ploiarium sessile (Scheff.) Hall. f. (Theaceae)
Podocarpus polystachyus R. Br. ex Endl. (Podocarpaceae)
Polyscias cumingiana (Presl) F.-Vill. (Araliaceae)
Pometia pinnata J.R. & G. Forst. (Sapindaceae)
Pongamia pinnata (L.) Pierre (Fabaceae)
Premna serratifolia L. (Verbenaceae)
Psychotria tripedunculata Sohmer (Rubiaceae)
Rauvolfia moluccana Markgrf. (Apocynaceae)
Rhizophora mucronata Lamk (Rhizophoraceae)
Rhodamnia novoguineensis A.J. Scott (Myrtaceae)
Rhynchospora rubra (Lour.) Makino (Cyperaceae)
Saccharum spontaneum L. (Poaceae)
Scaevola oppositifolia R. Br. (Goodeniaceae)
Scaevola sericea Vahl (Goodeniaceae)
Sophora tomentosa L. ssp. *tomentosa* (Fabaceae)
Spinifex littoreus (Burm. f.) Merr. (Poaceae)
Stachytarpheta jamaicensis (L.) M. Vahl (Verbenaceae)
Stenocarpus moorei F.v.M. (Proteaceae)
Styphelia abnormis (Sond.) J.J. Sm. (Epacridaceae)
Tacca leontopetaloides (L.) O.K. (Taccaceae)
Teijsmanniodendron bogoriense Koorders (Verbenaceae)
Terminalia catappa L. (Combretaceae)
Terminalia copelandii Elm. (Combretaceae)
Thespesia populnea (L.) Sol. ex Corr. (Malvaceae)
Timonius timon (Spreng.) Merr. (Rubiaceae)
Tournefortia argentea L.f. (Boraginaceae)
Trema cannabina Lour. (Ulmaceae)
Tridax procumbens L. (Asteraceae)
Tristaniopsis macrosperma (F. v. M.) Wilson & Waterh. (Myrtaceae)
Trophis philippinensis (Bur.) Corner (Moraceae)
Vatica rassak (Korth.) Bl. (Dipterocarpaceae)
Vigna marina (Burr.) Merr. (Fabaceae)
Vitex cofassus Reinw. ex Bl. (Verbenaceae)

Weinmannia fraxinea (D. Don) Miq. (Cunoniaceae)
Wikstroemia androsaemifolia Decne (Thymelaeaceae)
Ximenia americana L. var. *americana* (Olacaceae)
Xylocarpus granatum Koenig (Meliaceae)

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SOIL-DEPENDENT FIRE FREQUENCY: A NEW HYPOTHESIS FOR THE DISTRIBUTION OF PRAIRIES AND OAK WOODLANDS/SAVANNAS IN NORTH CENTRAL AND EAST TEXAS

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ABSTRACT

The distinctive historical vegetation pattern of alternating tallgrass prairies on clay soils and oak woodlands/savannas on sandy soils in North Central Texas and East Texas has been described for more than a century. Many authors have attributed this pattern to relatively high levels of soil moisture available for tree growth on areas of sandy soil, and conversely, inadequate levels of soil moisture for tree growth on clay soils. However, this explanation is not consistent with present day observations of rapid invasion of clay soils by woody vegetation. We propose an alternative hypothesis, that the historical distribution of prairies and woodlands in North Central and East Texas can be explained by soil-dependent variations in grass biomass and resulting differences in fire frequency and intensity.

RESUMEN

El patrón histórico de vegetación en el que alternan praderas con hierbas altas en suelos calcáreos y robledales /sabana en suelos arenosos en el centro-norte y este de Texas ha sido descrito durante más de un siglo. Muchos autores han atribuido este patrón a los niveles relativamente altos de humedad en el suelo disponible para el crecimiento de los árboles en áreas de suelo arenoso, y por el contrario, niveles inadecuados de humedad en el suelo para el crecimiento de árboles en suelos calcáreos. Sin embargo, esta explicación no es consistente con las observaciones actuales de invasión rápida de suelos calcáreos por vegetación arbórea. Proponemos una hipótesis alternativa, que la distribución histórica de las praderas y bosques en el centro norte y este de Texas puede ser explicada por las variaciones dependientes del suelo en la biomasa de las gramíneas y las diferencias resultantes en la frecuencia e intensidad del fuego.

INTRODUCTION

Conditions at the time of European Settlement, Approximately 1800 A.D.

The vegetation of North Central and East Texas at the time of European settlement (hereafter referred to as presettlement vegetation) was characterized by well-defined zones of tallgrass prairie and oak woodlands/savannas (Fig. 1).

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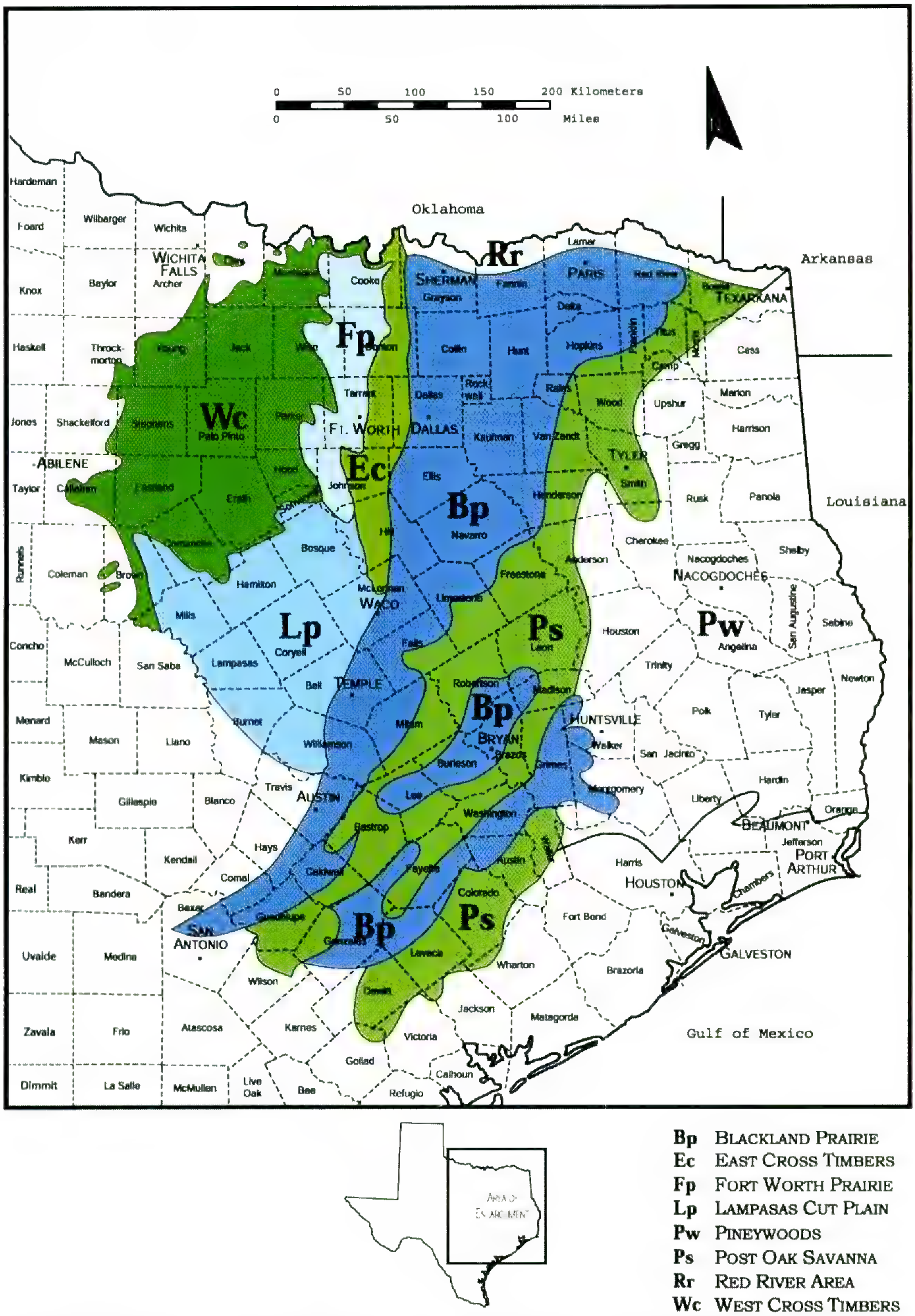


FIG. 1. Vegetational areas of North Central and East Texas. The Prairies are in shades of blue while the Woodlands/Savannas are in shades of green. Two vegetational areas of North Central and East Texas are not shown in color—the Pineywoods (forest) and the Red River Area (somewhat transitional between the Pineywoods and the Post Oak Savanna).

From west to east, the prairie bands are the Grand Prairie (composed of the Fort Worth Prairie and the Lampasas Cut Plain), the main belt of the Blackland Prairie, the San Antonio Prairie, and the Fayette Prairie, whereas the oak woodland/savanna belts are the West Cross Timbers, the East Cross Timbers, and three bands of Post Oak Savanna. These were highly recognizable areas of vegetation, with the Cross Timbers appearing on the earliest maps and the presettlement prairies described by numerous explorers, early settlers, and researchers as almost devoid of trees (e.g. Gregg 1844; Brooke 1849; Parker 1856; Dyksterhuis 1946; Thomas 1962; Correll & Johnston 1970; Hatch et al. 1990; Diggs et al. 1999; Telfair 1999; Francaviglia 2000). Hereafter we refer to these two vegetation types as Prairies and Woodlands. The current climate of the region, presumably relatively unchanged since presettlement times, is characterized by wet springs, dry summers with occasional thunderstorms, moderate to strong winds, and periodic multi-year droughts. As in many areas of central North America, prairie fires were common prior to settlement (Stewart 1951; Komarek 1965, 1966; Wells 1970; Wright and Bailey 1982; Collins & Wallace 1990; Bragg 1995). The relative frequency of ignition by lightning versus Native Americans is unclear.

The Woodlands represent the westernmost extension of the eastern deciduous forest. In general, the vegetation was composed of an oak overstory with tall grasses. The grasses were dominated by *Schizachyrium scoparium* (little bluestem), with *Andropogon gerardii* (big bluestem) and *Sorghastrum nutans* (Indian grass) as lesser dominants. While varying locally, the woody vegetation was in general dominated by two trees, *Quercus stellata* (post oak) and *Quercus marilandica* (blackjack oak). The tree density of the oak woodlands was variable, ranging from quite open to dense thickets. Some early accounts described woodlands through which wagons could easily pass (e.g. Marcy 1853, 1866), while others described almost impenetrable thickets (e.g. Kendall 1845). Gregg (1844) observed a variety of tree densities, noting that, "Most of the timber appears to be kept small by the continual inroads of the 'burning prairies;' for, being killed almost annually, it is constantly replaced by scions of undergrowth; so that it becomes more and more dense every reproduction. In some places, however, the oaks are of considerable size, and able to withstand the conflagrations."

The presettlement Prairies were vast grasslands dominated by *Schizachyrium scoparium* (little bluestem), with *Andropogon gerardii* (big bluestem) and *Sorghastrum nutans* (Indian grass) as lesser dominants, and woody vegetation generally limited to areas along the larger watercourses, as scattered mottes, or associated with locations that were protected from fire, such as mesas and buttes (Smythe 1852; Parker 1856; Hill 1901; Diggs et al. 1999). For example, Hill (1887) described the Grand Prairie as "a prairie region, utterly destitute of timber" and Kendall (1845) wrote, also of the Grand Prairie, "As far as the eye could reach ... , nothing could be seen but a succession of smooth,

gently-undulating prairies." Early accounts of the Blackland Prairie were similar. Smythe (1852) described the eastern edge of the Blackland Prairie as having "... a view of almost boundless Prairie stretching to the north, as far as the eye could reach. ..." and further, as "nearly destitute of trees."

Soils of North Central and East Texas

Most soils of the Prairies of North Central and East Texas are derived from lime-rich Upper Cretaceous rocks which weather to form soils with substantial levels of clay. Outlying segments of the Blackland Prairie (Fayette and San Antonio prairies) have soils developed from younger Tertiary age deposits. While the majority of Tertiary deposits in East Texas are sandy in nature (i.e., those supporting the Pineywoods and Post Oak Savanna), those underlying Prairie (e.g., Fleming, Oakville Sandstone, and Cook Mountain formations) in general have a relatively high clay content and in some cases develop soils which display the gilgai microtopography so typical of certain high clay soils (Launchbaugh 1955; Smeins & Diamond 1983; Miller & Smeins 1988). Further, where clay lenses are found in other geologic strata outcropping in isolated pockets of the Cross Timbers, Post Oak Savanna, and Pineywoods, areas of prairie vegetation can again be found (Dyksterhuis 1948; Hill 1991). It is thus clay that appears crucial in the development and maintenance of the grassland vegetation characteristic of the Prairies. In some cases clay is abundant throughout all soil horizons, while in others there is a clay-loam or loam surface layer—all the Prairie soils, however, have significant amounts of clay (Godfrey et al. 1973; Diamond & Smeins 1985). Conversely, the Woodlands are developed in general from Cretaceous and Tertiary sandstone rocks of such geologic layers as the Antlers/Trinity, Woodbine, Carrizo, and Wilcox, and can be generally described as sandy (Sellards et al. 1932; Hartmann & Scranton 1992).

Prevailing Explanation for the Distribution of Prairies and Woodlands

As discussed above, the presettlement distribution of the Prairies corresponds to the distribution of limestone parent material overlain by alkaline soils with a high clay content, while the presettlement Woodlands occurred on either sandy, slightly acidic soils or, in the westernmost part of the region, on gravelly and rocky substrates (Sellards et al. 1932; Dyksterhuis 1948; Diggs et al. 1999). The striking correspondence of vegetation and soil types led early writers to propose that the distribution of Prairies and Woodlands was due to the different water holding capacities of clays and sands. While the basic hypothesis has been stated many ways, its essence is that greater infiltration and water storage at depth in sandy soils permits tree survival, while clay soils do not support trees because of inadequate infiltration of water (and reduced root penetration) due to the clay's relative impermeability.

Hill (1887) appears to have been the first to propose this hypothesis. He argued that,

> "The reason why the timber confines itself to [the sandy soils is that they] ... afford a suitable matrix for the penetration of the roots of trees, and a constant reservoir for moisture, thus furnishing two of the greatest essentials to forest growth. ... The barrenness of the prairies, so far as forest growth is concerned, is owing to the absence of the requisite structural conditions for preservation of moisture, as well as the excess of carbonate of lime in their soils."

Subsequent authors reiterated Hill's contention. For example, Tharp (1926) suggested that the sandy soils increased available soil moisture for tree growth. Weaver and Clements (1938) argued that, "... the oaks ... have been able to maintain themselves against the competition of the grasses by virtue of the favorable chresard of the sandy soil." Dyksterhuis (1948) summarized much of this information, and apparently agreed with the general idea of sandy soil-moisture availability favoring the growth of trees. Allred and Mitchell (1955) reiterated these ideas:

> "Sandy, gravelly and rocky areas ... also improve local soil-moisture conditions in the grassland formation. Rainfall intake is high on these soils, which also yield up moisture to plants more readily and more completely than do heavier soils. ... In these areas, soil-moisture conditions have been improved sufficiently over the climatic normal so that trees or shrubs, particularly oaks, form savannah with the understory composed of grassland dominants of the True Prairie."

This reasonably intuitive explanation for the historic distribution of the Prairies and Woodlands has been nearly universally accepted, including by recent authors (e.g., Diggs et al. 1999; Francaviglia 2000).

However, the hypothesis that the Woodlands are restricted to sandy soils because of inadequate moisture availability on clay soils cannot be correct because, in fact, trees occur extensively on the clay soils. As noted above, early accounts noted woody vegetation along the larger watercourses and as isolated mottes or clumps of trees in scattered locations on the clay soils of the Prairies. More impressive, however is the current invasion of trees onto extensive upland areas of clay soil that can be widely observed throughout the Prairies (e.g., Launchbaugh 1955; Smeins & Diamond 1986). Indeed, the few remaining prairie remnants require active management to prevent loss to invading woody vegetation (Smeins & Diamond 1986). In the absence of fire, mowing, or some other suitable disturbance, trees such as *Juniperus virginiana* (eastern red cedar), *Gleditsia triacanthos* (honey-locust), *Celtis laevigata* (hackberry), *Maclura pomifera* (bois-d'arc), *Prosopis glandulosa* (mesquite), and *Ulmus crassifolia* (cedar elm) rapidly invade the native prairie and cause the vegetation to convert to a thicket and then a woodland/forest. A glance from the road along almost any major highway on the present day Blackland Prairie provides abundant evidence of rapid invasion by woody species in the absence of disturbance (Fig. 2). In areas no longer cultivated or otherwise disturbed, the invasion by trees can be observed within a relatively few years—this is particularly obvious in the numerous areas that were cultivated until relatively recently. It therefore seems clear that there is sufficient moisture for tree growth on the clay soils and



Fig. 2. Area of Blackland Prairie in Grayson County showing invasion by woody vegetation under current fire supression conditions (photo by W. Cole Weatherby)

some other mechanism or mechanisms must have been responsible for the historical difference in the vegetation on the clay Prairies and sandy Woodlands.

It should be noted that the woody species present on the modern day Prairies and Woodlands are largely different, probably due to the different soil requirements of the various species, and we do not view woody plant encroachment on the Prairies as simply an expansion of the Woodlands. Nonetheless, woody vegetation is now extensive on many formerly Prairie areas. The woody species currently encroaching on areas of Prairie vegetation were probably not in general major components of the adjacent presettlement Woodland vegetation. Rather, they are probably species that in presettlement times were present in low numbers on the Prairies themselves near streams or where topography made fire unlikely. On the other hand, some species (e.g., *Juniperus ashei*, *J. virginiana*) are at present highly invasive on both the Prairies and Woodlands.

HYPOTHESIS

Soil-dependent fire frequency

We propose that the presettlement distribution of Prairies and Woodlands in North Central and East Texas was not due to insufficient moisture for tree growth on clay soils, but rather to differences in fire frequency on different soil

types. We hypothesize that higher fuel quantity on clay soils increased the frequency and intensity of fire, and that fire in turn suppressed the growth of trees. Prairie fires are fueled primarily by grasses, as opposed to forbs or woody vegetation, so an increase in grass biomass leads to an increase in the quantity of fuel. We predict that grass biomass is typically higher on clay than on sandy soils due to better moisture and nutrient availability at the shallower rooting depth of grasses versus woody plants.

This situation would represent two alternative positive feedbacks. High fuel quantity on clay would encourage fire, which would suppress woody vegetation and under certain conditions (e.g., depending on season of burn—Howe 1995) stimulate subsequent grass growth (by removing dead biomass which hinders new growth), thereby maintaining high fuel quantity. Low fuel quantity on sand would reduce the chance of fire, which would foster invasion by trees that would then further suppress grass biomass (e.g., by shading or other competition) and the subsequent frequency and intensity of fire. These alternative feedbacks would lead to alternative stable states, Prairies and Woodlands (Fig. 3). This particular hypothesis for the distribution of Prairies and Woodlands is consistent with the more general conclusions of Scholes and Archer's (1997) review of tree-grass interactions around the world. They write that "Moist fertile environments [e.g. our Prairies] support a vigorous grass growth that, if not grazed, leads to frequent intense fires.... Semi-arid environments on sandy, low fertility soils [e.g. our Woodlands] are seldom treeless."

Soil type (and its effects on grass biomass) is not the only variable that affects the frequency or intensity of fire. Whether a fire ignites, how hot it burns, and its ability to spread also depend on a number of other variables including frequency of ignition events, season of year, rainfall, humidity, wind speed, topography, and grazing (some of which also affect grass biomass). These variables would combine in a stochastic manner to increase or decrease the frequency and/or intensity of fire in any given location at any particular time. For example, fire frequency and intensity would be low during a wet summer, but the resulting grass growth could combine with a subsequent windy drought to increase fire likelihood and intensity the following year. Thus, the systematic effect of soil type on fire would be increased or decreased at any given location at any particular time by the net effect of these other variables, with the result being substantial variation in the time since the last fire in different areas of both the Prairies and the Woodlands. When this stochastic variation is taken into account, the fire-frequency hypothesis can explain not only (1) the historical distribution of Prairies and Woodlands, but also: (2) the historically dominant tree species of the Woodlands; (3) the historical occurrence of isolated groves of trees on clay soils; (4) the present invasion of Prairies by trees; and (5) the difference between the historically dominant tree species of the Woodlands and the species that are increasing in abundance on the Woodlands and invading the Prairies today (e.g., *Juniperus* species).

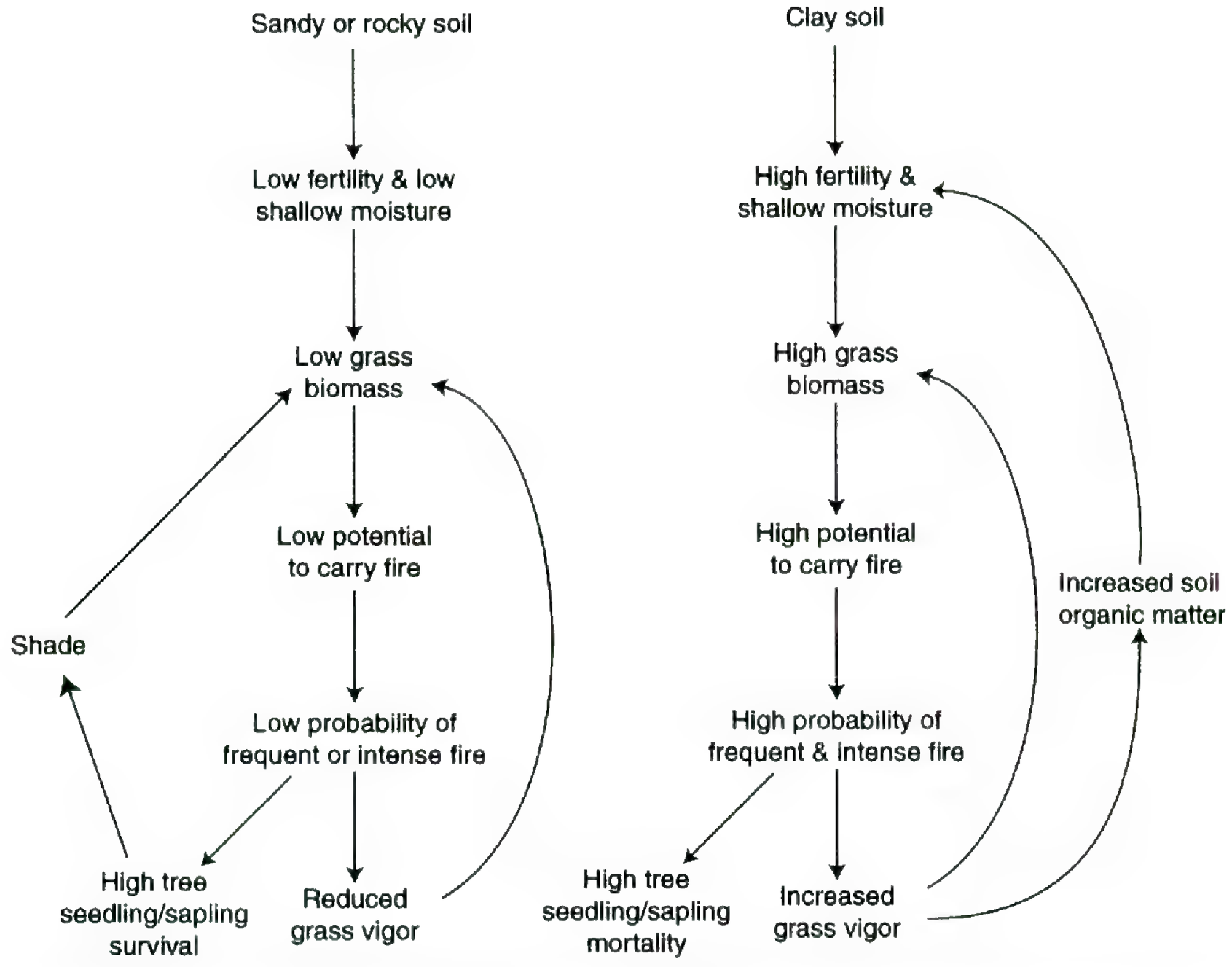


FIG. 3. Flow diagram showing two positive feedback routes to two alternative stable states.

The Woodlands were historically dominated by oaks, species with thick bark, stubby branches, and the ability to resprout from roots, features that impart resilience to grass fires. Further, occasional extended periods without fire on the Prairies would have allowed the establishment of the isolated groves of trees that were observed by Western settlers. Once established, such groves would have been unlikely to burn due to the suppression of grass growth by the trees and the resistance of large trees to fire.

The present invasion of the Prairies by trees can be explained by a lack of fire that has resulted from intentional fire suppression plus numerous and extensive fire breaks that have been created by human activities (roads, cultivated fields, overgrazed areas). Moreover, once this process begins, any Prairie area that becomes substantially invaded by trees would lose grass biomass and come to serve as an additional firebreak, thereby further reducing the likelihood of fire on adjacent remaining prairies. Finally, the present tree invasion of many (but certainly not all) areas of the Prairies (and of the Woodlands understory) is dominated by *Juniperus virginiana* (eastern red cedar) and *Juniperus ashei* (Ashe's juniper), species that are sensitive to fire (easily scorched/ignited and unable to resprout from roots).

The key assumption of our hypothesis is that the difference in grass biomass was sufficiently higher on the Prairies than the Woodlands to raise the likelihood, frequency, and intensity of fire on the clay soils of the Prairies compared to the sandy or rocky soils of the Woodlands. In addition, our hypothesis leads to the prediction that patches of open grassland on sandy soil are very rare except in instances of active management (e.g., suppression of woody species) or immediate proximity to clay soils (which would result in more frequent fires due to closeness to the fire-prone prairie vegetation).

We have not measured grass biomass on intact remnants of the Prairies and Woodlands, and therefore do not have the data necessary to estimate differences in a number of variables associated with fire (e.g., frequency, intensity, extent, pattern, season, etc.). Further, while some biomass and fuel loading data are available in the literature (e.g., Johnson & Risser 1974; Engle & Stritzke 1995), we have been unable to find directly comparable data for the area of study. However, substantial indirect evidence is consistent with the assumption of higher grass biomass on clay soils. First, during dry periods clay soils generally hold more water at grass rooting depths than do sandy soils. This is due to the relatively large surface areas of the individual clay particles and the large number of very small pores which act as billions of capillary tubes collectively holding large amounts of water (Vankat 1979). The result of this increased water holding capacity is that plants rooted in such soils may continue active growth much later in the dry season than plants rooted in coarser soils (Daubenmire 1974; Burgess 1995; McAuliffe 1995; Tucker 1999; Greeves et al. 2000; Ball 2001). Furthermore, undisturbed Blackland soils form gilgai, microtopographical surface features that function like shallow basins, increasing water retention during heavy rains (Hayward & Yelderman 1991; Diamond & Smeins 1993). Early settler accounts and observations of existing prairie remnants (e.g., the Nature Conservancy's Clymer Meadow preserve in Hunt County, the Matthews-Cartwright-Roberts Prairie in Kaufman County, and Austin College's Garnett Prairie in Grayson County) suggest that these "hog wallows," (as they were known to early settlers) were abundant on Vertisols of the presettlement Blackland Prairie. Temporary water storage in gilgai depressions of one-half acre foot of water per acre of flat prairie have been estimated. As much as six inches of rain could be temporarily trapped in these structures before runoff began (Hayward & Yelderman 1991). Meanwhile, the high surface area and negative surface charges of clay particles give clay soils high cation exchange capacity. This allows these soils to hold more ionized minerals or nutrients, including those essential for plant growth (Foth 1990; Whitehead 2000; Harpstead et al. 2001; O'Connell 2001). It is therefore not surprising that indirect evidence, such as agricultural productivity, suggests that the Blackland clay soils were among the most fertile soils west of the Mississippi River (Haywood & Yelderman 1991). In addition, the high below-ground biomass of Prairie vegetation serves to con-

tinually add organic matter to the soil, thereby functioning as a positive feedback mechanism to increase fertility and water holding capacity (in part due to the surface area provided by the additional organic material). Conversely, sandy soils have larger pores that allow water to drain more easily. They not only dry earlier during dry periods but "the more water that percolates through the soil, the more nutrients are washed out—particularly nitrogen, potassium and sulfur" (Tucker 1999). Therefore, soils that are high in sand, like those of the Woodlands, are often poor for plant growth since they are relatively infertile and often too well-drained (Vankat 1979).

Confounding factors

Several other factors have the potential to operate synergistically or in opposition to the soil-mediated fire frequency hypothesis in influencing the balance between grass-dominated and woody vegetation. Of particular importance is the grazing regime. Van Auken (2000), for example, has identified high levels of herbivory by domestic animals as the primary cause of brush encroachment in the semiarid grasslands of the southwestern U.S. This influence is probably the result of a combination of disturbance and reduced fire frequency. The grazing regime during presettlement times was certainly very different than at present. Instead of domestic animals continuously confined to limited areas of pasture, the primary herbivores were large dense herds of migratory bison free to move over vast distances. The grazing regime would thus have been extremely irregular both temporally and spatially. While a large herd could move through an area of Blackland Prairie and crop the vegetation very short (thus preventing fires), in some seasons or years a given area would probably be missed entirely leaving large amounts of standing biomass (heavy fuel load for fires). Under such conditions fire would not be expected every year, nor would it be essential every year for the maintenance of the grassland. Rather, fire would be critical only with enough regularity to prevent trees from growing large enough to become invulnerable to grass fires.

Another grazing related influence is the role of dense herds of grazers on controlling woody vegetation and stimulating grasses. Savory (1998) has stressed the importance of herding grazers on maintaining grasslands and has emphasized the extremely different consequences of typical human-controlled grazing regimes (long periods of exposure to low densities of animals) and natural systems (large migratory herds at high density due to threat of predation). He has noted that extremely high densities of grazers (and thus damage to woody plants) may be of critical importance in preventing encroachment of woody vegetation and shifting the balance in favor of grazing adapted grasses. A different impact of grazers is that seed dispersal may be of major importance in the invasion of grasslands by certain woody species. Data of Brown and Archer (1999) suggest that rates and patterns of seed dispersal may be the primary de-

terminants of encroachment by mesquite (*Prosopis glandulosa*) on present-day landscapes in semi arid regions of the American southwest.

Still another confounding factor is the competition for resources between grasses and woody species in an intact prairie ecosystem. Under certain conditions (e.g., of soil, water, grazing, etc.) on an intact prairie, grasses might be able to out compete woody species or at least resist their invasion, with or without the influence of fire. However, the impact of fire and grazing are of critical importance since under natural conditions it is unlikely that either of these factors would be absent for any significant length of time.

CONCLUSION

The soil-mediated fire frequency hypothesis is merely a particular case of a group of mechanisms that, by reducing the frequency and intensity of fire, enable trees to grow where grass would otherwise dominate. The fire induced state of grasslands on the Prairies is therefore apparently destabilized when fire is suppressed for any of a number of reasons. In addition to the hypothesized effect of soil on grass biomass, other variables that can hinder fire and thus allow trees to invade include precipitation, grazing, and topography (Collins & Wallace 1990; McPherson 1995). Trees invade when rainfall prevents fire throughout the year (e.g., in areas of eastern deciduous forest in the eastern U.S). Likewise, reduced grass biomass from grazing on the Prairies reduces fire likelihood, which in turn enables invasion by trees (Smeins et al. 1982; Scholes & Archer 1997; Van Auken 2000). As noted by Van Auken (2000), "the driving force [for brush encroachment] seems to be chronic, high levels of herbivory by domestic animals. This herbivory has reduced the aboveground grass biomass, leading to the reduction of fine fuel and a concomitant reduction or complete elimination of grassland fires. This combination of factors favors the encroachment, establishment, survival and growth of woody plants." Finally, where relief is extreme, as on scarps or cliffs, woodlands are often present. This is due to both the thin rocky soil (and hence low grass biomass) and the topography (e.g., abrupt scarps), which often creates natural firebreaks (Wells 1965, 1970; Axelrod 1985). Thus, any factor that reduces fire likelihood, frequency, or intensity can be expected to allow trees to invade grasslands in areas where there is sufficient moisture for tree growth. The soil-mediated fire frequency hypothesis for the historical distribution of the Prairies and Woodlands of North Central Texas and East Texas is consistent with both historical vegetation patterns and recent changes in the vegetation, and is simply a special case of a generally accepted explanation for tree-grass interactions.

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BOOK NOTICES

HOWARD GARRETT. 2002. **Howard Garrett's Texas Trees.** (ISBN 0-89123-076-9, hbk.). Taylor Wilson, 1900 West Loop South, Suite 1900, Houston, TX 77027, U.S.A. (Orders: 713-980-1950, fax 713-980-2429, 800-570-0082, www.taylorwilson.com). $29.95, 253 pp., color throughout, 7" × 10".

Texas is a big state with a wide range of climate, soil and water quality, and knowing when to plant the proper tree is crucial. *Howard Garrett's Texas Trees* is a handy reference for everyone from your basic gardener to degreed botanist. According to Dr. Garrett "This book is about horticultural details, as well as my opinions on weather and how to use the various trees available in Texas."

Everything needed to identify over 100 varieties of Texas trees is here in this one source—along with easy-to-follow directions for selecting, planting, and maintaining your trees. Howard takes a very common sense approach (as with all his books) to planting, propagating and all things trees.

Included in the book is an in-depth Tree Glossary with full details (and great color photos) as well as descriptions of natural habitats, identification information, maintenance, propagation, problems, culture, flowers, fruit, and foliage. Also included is a handy little index of pests, diseases, funguses and organic treatment methods, like the Basic Organic Program, which Garrett developed.

In summary, I would like to recommend adding this book to your library. It's an excellent reference for native and introduced trees to the region, and would be a great reference guide for anyone in the botanical world.—*Asha McElfish, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

MICHAEL A. ARNOLD. 2002. **Landscape Plants for Texas and Environs, Second Edition.** (ISBN 1-58874-153-2, hbk.). Stipes Publishing L.L.C., 202-204 West University Ave. P.O Box 526 Champaign, Ill. 61824-0526 (Orders: 217-356-8391, stipes@soltec, www.stipes.com). $68.00, 1088 pp., line drawings, maps, 8 1/2" × 11".

Dry, but well-researched and to the point is how I would best describe Arnolds newest book, *Landscape Plants for Texas and Environs*. According to the book "The text was developed as a reference for nursery and landscape professionals and as a study aide for students of Texas landscaped plants."

The book probably won't win any design award, as the pages are laid out it in a plain black and white blocked format with large line drawings and species descriptions; no color photographs are found in the book except on the covers.

For each species covered it includes: Other Common Names, Family, Cold Hardiness, Foliage, Flower, Fruit, Stem/Bark, Habit, Cultural Requirements, Pathological Problems, Ornamental Diseases, Limitations & Liabilities, Landscape Utilization, Native habitat, and Related Taxa.

Personally I find this book to be lacking in the attention grabbing area of color, but it is easy to read, well-researched, and you can find what you're looking for quickly. Definitely not a book you put on your coffee table to show off, but one you will probably find yourself wanting when researching the Texas flora for landscape plants.—*Asha McElfish, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

FLORA AND VEGETATION OF THE MOHAWK DUNES, ARIZONA

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ABSTRACT

One-hundred twenty-two species of seed plants, representing 95 genera and 35 families are documented for the 7,700 ha Mohawk Dune Field and its immediate surroundings, located in Yuma County, Arizona, USA. Three major habitats were studied: dunes, adjacent sand flats, and playa. The dunes (including interdune swales) support 78 species, of which 13 do not occur on the adjacent non-dune habitats. The adjacent non-dune habitats (sand flats and playa) support 109 species, of which 43 were not found on the dunes. The total flora has 81 annual species, or 66% of the flora. The dune flora has 63 annual (ephemeral) species, or 81% of the flora—one of the highest percentages of annuals among any regional flora. Of these dune annuals, 53 species (84%) develop during the cool season. No plant taxon is endemic to the Mohawk region. There are 8 dune, or sand adapted, endemics—*Cryptantha ganderi, Dimorphocarpa pinnatifida, Dicoria canescens, Ditaxis serrata, Pleuraphis rigida, Psorothamnus emoryi, Stephanomeria schottii, Tiquilia plicata*—all of which are found on nearby dune systems. Two of them (*C. ganderi* and *S. schottii*) are of limited distribution, especially in the USA, and have G2 Global Heritage Status Rank. There are four non-native species in the dune flora (*Brassica tournefortii, Mollugo cerviana, Sonchus asper, Schismus arabicus*), but only *Brassica* and *Schismus* seem to pose serious threats to the dune ecosystem at this time. The Mohawk Dune field is within the Lower Colorado Valley phytogeographic region of the Sonoran Desert and located within the Barry M. Goldwater Military Range. This unique dune system, largely unaffected by human activities, is recommended as a site for baseline studies of plant migrations and population dynamics affected by global climatic change.

RESUMEN

Ciento veintidos especies de espermatófitos, que representan 95 géneros y 35 familias se documentan para las 7.700 ha del Mohawk Dune Field y sus alrededores, en el condado de Yuma, Arizona, USA. Se estudiaron tres grandes hábitats: dunas, arenales planos, y playas. Las dunas (incluyendo las depresiones interdunares) tienen 78 especies, de las que 13 no se dan en los hábitats no dunares adyacentes. Los hábitats adyacentes no dunares (arenales planos y playa) tienen 109 especies, de las que 43 no se encontraron en las dunas. La flora total tiene 81 especies anuales, o el 66% de la flora. La flora dunar tiene 63 especies anuales (efímeras), o el 81% de la flora—uno de los porcentajes más altos de anuales en las floras regionales. De estas anuales dunares, 53 (84%) se desarrollan durante la estación fría.

DUNE SYSTEMS AND ENVIRONMENT

Dunes inspire thoughts of barren desert, windblown and inhospitable. Yet dunes can support substantial and unique plant life. Sand dunes occur around the globe

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as both coastal and inland systems, and are not restricted to deserts but are often prominent features of major deserts. Dunes are relatively rare in the Americas, covering about 0.5% of the arid zones in North America (Bowers 1982, 1984). The major Sonoran Desert dune fields are the Gran Desierto Dunes of northwestern Sonora and the related Algodones Dunes of southeastern California. Hot-desert dune plant communities must cope with an array of challenging growth conditions, including burial, root exposure, wind shear, and low nutrient levels. As a result, dune floras are frequently characterized by high levels of endemism and specialized adaptations (Bowers 1982). Despite these challenges, Shreve (1951:127) pointed out that "Sand...is a particularly favorable soil for the ephemerals of the cool season, because of the deep infiltration of moisture and the rapid warming of the surface early in the season and early in the day."

This publication reports the composition and characteristics of the flora and vegetation of the Mohawk Dunes, reflecting accumulated data from numerous visits to the area by the authors spanning more than five years, as well as herbarium records of other collectors. The first section describes dune systems and the physical environment, management, and global significance of the Mohawk Dunes in particular. The second section is a description of the Mohawk Dune vegetation and flora, and the third catalogues its flora, containing species accounts for each of the 123 species of the dune system and the immediately adjacent desert flats.

PHYSICAL CHARACTERISTICS OF THE MOHAWK DUNES

The Mohawk dune field is located about 65 km east of Yuma, Arizona, on the eastern side of the Mohawk Valley in Yuma County (Broyles et al. 1997). The region is within the Lower Colorado Valley phytogeographic subdivision of the Sonoran Desert (Shreve 1951). The Mohawk Valley is roughly 28 km wide, forming a nearly flat plain with moderately sandy soils. Steep, rocky mountain fronts bound the valley to the east and west, similar plains stretch far to the south, and the north end is bounded by agricultural fields along the now usually dry Gila River. The valley lacks any well-defined central drainage channel, with the mountain fronts draining into ephemeral stream channels, which rapidly shrink to insignificance. The elongated dune system runs parallel to, and west of the Mohawk Mountains, trending northwest to southeast (Fig. 1). Small, scattered outlier dunes occur in the San Cristobal Valley east of a pass in the Mohawk Mountains. The Mohawk dune field is about 32 km long and varies in width up to 3.2 km wide, covering approximately 7,770 ha. Maximum elevation is 207 m near the center of the dunes, rising about 55 m above the surrounding desert. The underlying desert floor rises gently from an elevation of 116 m at the north end of the dunes to 192 m at the south end (Smith & Bender 1973).

The dune contours consist of a fairly regular series of depressions surrounded

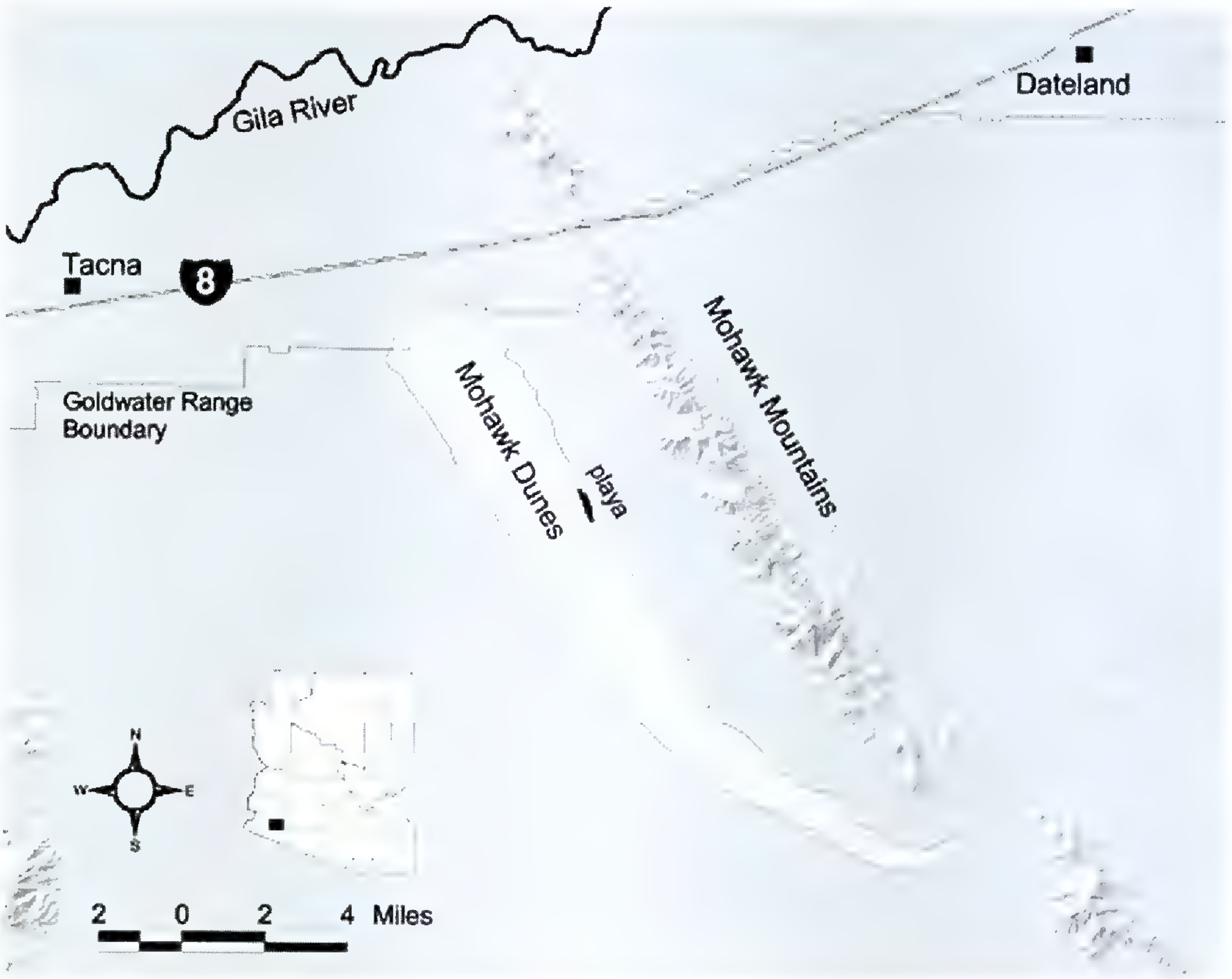


FIG. 1. Location of Mohawk Dunes in southwestern Arizona.

by ridges, resembling a honeycomb in aerial view. Swales—low areas between dunes—and the surrounding crests form microhabitats with significantly different plant and animal communities. The crests are characterized by shifting or slightly stabilized sands and a dominance of sand-adapted species. In contrast, the swales have soil textures and species assemblages that more closely resemble the desert surrounding the dune field (Turner et al. 1997a). The swales are also notable for having a much more stable surface. This is largely maintained by a well-developed microbiotic crust dominated by the cyanobacterium *Microcoleus vaginatus* and the lichen *Collema* sp. (Jane Belnap, pers. comm.).

The Mohawk Dune system appears to have been in place for an extended period. Extensive layers of calcium carbonate are evident on swale slopes, and we have found numerous fossil remnants of tortoises and other vertebrates. The dune sand is composed mainly of quartz and feldspar. According to Bowers (1986:57), "... the Mohawk Dunes have garnered all the sand available for their formation: no more sand is being blown into the dune field." It seems reasonable to suspect that an earlier configuration of the Gila River was the source of sand for these dunes, but that question remains unstudied.

A distinctive playa (the bed of an ephemeral lake), 1,400 m × 250 m, lies along the eastern side of the dunes, about 8 km south from the dune field's north end (Fig. 1). It appears to fill to a depth of <1 m with a frequency of about once per decade, most recently in winter 1992–93. Its more common aspect features sun-baked clay with an extensive network of deep cracks.

Climate

Air temperature regimes for the area are typical of the lower Sonoran Desert, with mean daily maxima of 40-43°C for June through September, and peaks in excess of 49°C during midsummer (Sellers & Hill 1974). Surface temperatures on the dunes reach greater extremes, with June and July maxima averaging above 65°C in 1996. Relative humidity is generally low, dropping below 10% on most days in the summer and many days in winter (Turner, unpubl. data).

Annual rainfall averaged 10.54 cm from 1900-1951 at the nearest weather station, Mohawk, ca. 5 km northeast from the north end of the dune field. About half of the annual total, 4.85 cm, fell during the May-October warm season, primarily during July-September, while 5.72 cm fell November-April (Sellers et al. 1985). Months with no rain are common, and summer storms can deliver a large fraction of the total annual precipitation in a short period (Sellers & Hill 1974).

Although rainfall data from nearby stations may be indicative of regional trends and normal year-to-year variation, they may not provide accurate data on local precipitation. A six-year study in Yuma showed that summer rainfall can vary by more than 2.5 cm for sites only 1.6 km apart (Turnage & Mallery 1941). Rain gauges at the Mohawk Dunes separated by 9.3 km recorded 2.54 and 0.38 cm for the same period of August through October 1994. The same two gauges recorded 0.46 and 3.30 cm respectively for a single storm event in July 1996 (Turner, unpubl. data). Such variation can cause dramatic differences in vegetative composition and abundance between sites.

Mohawk Dunes as a Long-Term Research Site

The Mohawk Dunes and surrounding landscape are part of the Barry M. Goldwater Military Range, jointly managed by 56th Range Management Office at Luke Air Force Base and the Range Management Department at Marine Corps Air Station, Yuma (Felger et al. 1997; Tunnicliff et al. 1986). The western part of the range including the Mohawk Dunes is managed by the Marine Corps and lands to the east are managed by the Air Force. Civilian access requires permission from the military. Military activities have impacted only approximately 5-12% of the entire 690,000 ha Goldwater Range and have had very little apparent affect on the dune biota. To date the military has provided substantial protection from the damaging recreational activities common to other dune systems in the American Southwest, and the Mohawk Dunes remain largely unaffected by human activity. However, future military and civilian effects on the dunes will be determined by management plans now under discussion.

The dunes are a popular destination for the public during spring wildflower displays, and there is occasional illegal off-road driving. Planning should assure undisturbed areas for monitoring and research, while other areas have access but with precautions to insure minimal impact.

Our understanding of global diversity is hindered by the lack of knowledge of changes in species composition over time so that processes of colonization, extinction, and evolution cannot be thoroughly described. This underlines the importance of maintaining areas that remain undisturbed by human development and that have protected status or the potential for protection due to land ownership. The manageable size of the Mohawk Dunes makes them an excellent candidate as a long-term research site. Careful stewardship of the dune field will serve to protect their value to our understanding of ecosystem processes.

METHODS

This report reflects accumulated data from numerous trips to the area with primary collections during 1995-1998. Specimens are at ARIZ, with duplicates for most species variously going to other herbaria, e.g., ASU, RSA, SD, and the Yuma District Office of the Bureau of Land Management. We also examined additional specimens, primarily at ARIZ, ASU, and RSA.

As part of an ecological inventory and monitoring program (Turner et al. 1997 a, b), plant cover sampling was done at two sites in the dune system using a stratified random sampling design to characterize the crest and swale plant communities. This involved randomized placement of quadrats along curvilinear transects which stayed either on crests or in swales, along transects which were previously established for a lizard monitoring program. Dune crests were sampled with a 1-km transect at a site on the east side of the dunes near the playa and two 500-m transects on the west side. Swales were sampled with a single 1-km transect near the playa.

We used quadrats 0.5 × 2 m, to take 200 samples out of a 10-m-wide swath along each 1-km transect, or 100 samples for each 500-m transect, for a representative sample of 1 ha for each sample site. Sampling was conducted during March 1996, following an unusually dry year, and thus measured almost exclusively perennial species.

VEGETATION AND FLORA

The total flora of the Mohawk Dune Region (dune and non-dune habitats) is comprised of 122 vascular plant species in 95 genera and 35 families. The most diverse families are the Asteraceae, Fabaceae, Poaceae, and Brassicaceae (Table 1). The most diverse genera are *Camissonia* with 4 species and two subspecies, *Cryptantha* with 4 species, and *Ambrosia* and *Boerhavia* each with 3 species. The growth-form spectrum is shown in Fig. 2. The different life forms are more

or less evenly distributed between the dunes and sand flats except that all but one (*Prosopis*) of the tree and large-shrub species (microphanerophytes) are absent from the dunes (Table 2). The total flora has 81 annual or ephemeral species, or a remarkable 66% of the flora (see discussion below for dunes). In contrast the ephemeral/annual flora of northwestern Sonora comprises 46% of the total flora, and across much of the Sonoran Desert the ephemerals make up about 50% of the total flora (e.g., Felger 2000; Venable & Pake 1999).

During the warmer months, often April and early May, and again with summer-early fall rains, many of the common ephemerals can be ravaged by caterpillars of the white-lined sphinx moth (*Hyles lineata*) (Fig. 10). Plants favored by these caterpillars include *Allionia incarnata*, *Boerhavia* spp., *Euphorbia abramsiana*, *Kallstroemia californica*, *Lupinus arizonicus*, and *Pectis papposa*.

Vegetative cover by perennial plants

Vegetative cover data were gathered during an unusually dry spring. Eight plant species were found living in 600 quadrats. We found almost no annual plants at that time. Mean ground cover on the dune crests ("dunes") ranged from 7-15%, while that in the swales was about 9% (Table 3). Dominant perennial species on the crests included *Ambrosia dumosa*, *Aristida californica*, *Ephedra trifurca*, *Pleuraphis rigida*, and *Psorothamnus emoryi*. The swales had a similar suite of species, with the addition of *Larrea divaricata* and a strong reduction in *Psorothamnus emoryi*.

Habitats

Bowers (1982) found that plant communities on dunes are mixtures of dune endemics, widely distributed plants of sandy soils, and plants found in adjacent, non-dune habitats. The desert flats, or sand flats, and the small playa are the non-dune habitats adjacent to the Mohawk Dunes.

Dunes.—During years of favorable winter-spring rainfall, such as certain El Niño years, the dunes support spectacular displays of wildflowers. Among the most conspicuous are sand verbena (*Abronia villosa*), desert marigold (*Baileya* spp.), desert cryptantha (*Cryptantha angustifolia*), spectaclepod (*Dimorphocarpa pinnatifida*), Arizona lupine (*Lupinus arizonicus*), evening-primrose (*Oenothera deltoides*), and Spanish needles (*Palafoxia arida*). Notably prominent are plants with dense whitish- or silvery-haired leaves and stems, e.g., *Ambrosia dumosa*, *Dicoria canescens*, and *Psorothamnus emoryi*. Deep roots are likewise a common feature, enabling plants to utilize moisture deep in the sand.

The floristic makeup of the dune communities, particularly among perennial species, is highly predictable, with relatively little change in species com- *Psorothamnus emoryi*, *Tiquilia plicata*; Ephemerals—*Abronia villosa*, *Dicoria canescens*, *Dimorphocarpa pinnatifida*, *Lupinus arizonicus*, *Oenothera* plants higher, shifting (moving or unstable) dunes are: Perennials—*Ambrosia dumosa*,

TABLE 1. Four largest families.

Family	Genera	Species
Asteraceae	17	21
Fabaceae	9	11
Poaceae	7	9
Brassicaceae	7	7

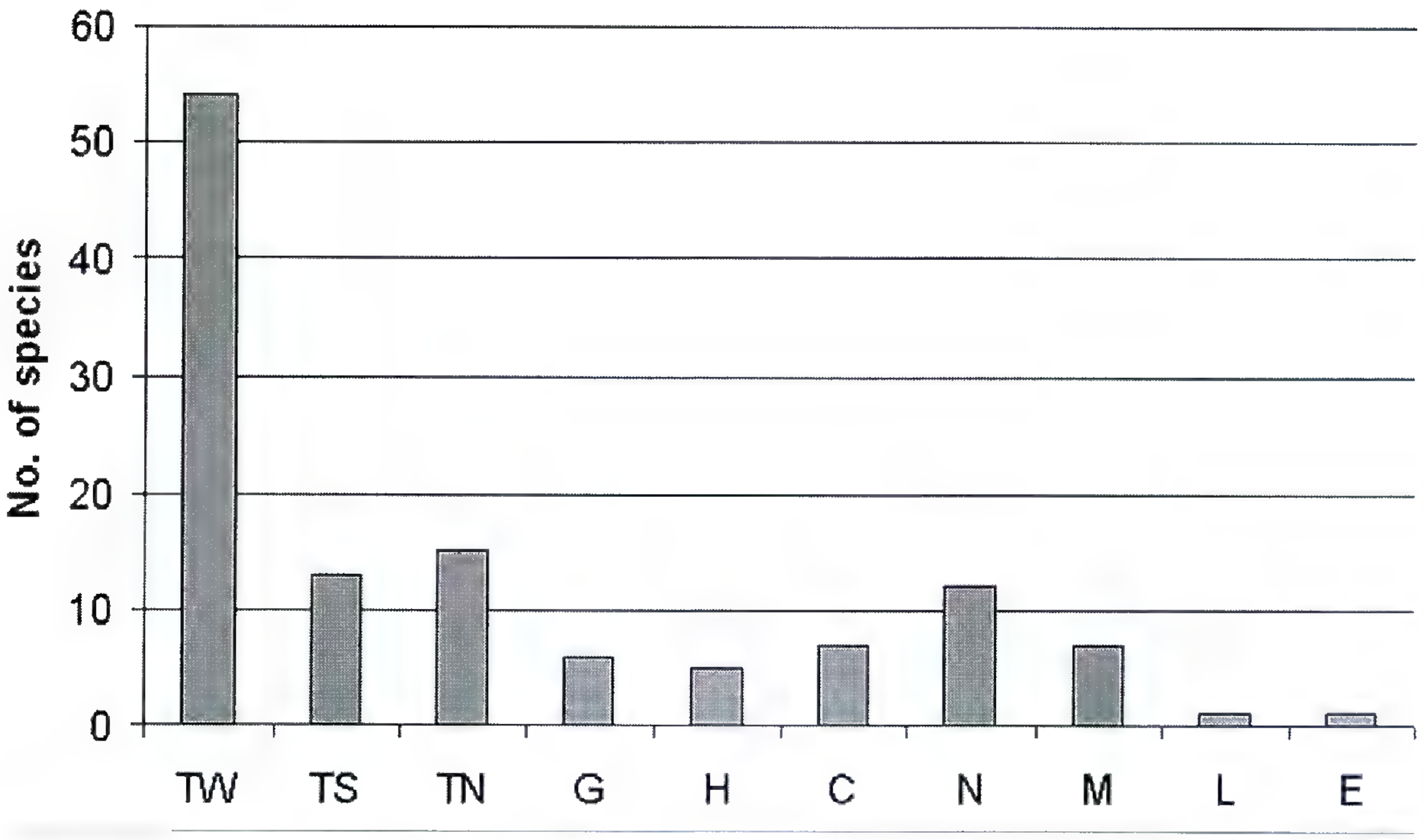


FIG. 2. Life-form spectrum of the Mohawk flora. **TW** = winter-spring or cool-season therophytes (annuals or ephemerals); **TS** = summer or hot-season therophytes; **TN** = non-seasonal therophytes; **G** = geophytes (perennials with meristem below ground); **H** = hemicryptophytes (perennials with meristem [growth bud] at or near the soil surface; **C** = chamaephytes (perennials with meristem above ground but usually less than 0.5 m tall); **N** = nanophanerophytes (shrubs or shrub-sized perennials, usually 0.5–2 m tall); **M** = microphanerophytes (trees or shrubs usually 2–8 m tall); **L** = perennial liana or vine; **E** = epiphyte.

position across the dune fields. Among the most common and conspicuous on *Aristida californica, Ephedra trifurca, Pleuraphis rigida, deltoides, Stephanomeria schottii*, and many others. Characteristic common plants on low, partially stabilized dunes as well as other sandy habitats include: Perennials—*Ambrosia dumosa, Aristida californica, Larrea divaricata, Pleuraphis rigida, Tiquilia palmeri*; Ephemerals—*Abronia villosa, Brassica tournefortii, Eriogonum trichopes, Oenothera primiveris, Schismus arabicus, Stephanomeria schottii*, and many others.

The dunes support 78 species, of which 13 do not occur on the adjacent non-dune habitats (Table 2). The dune flora includes 63 annual or ephemeral

TABLE 2. Distribution of the Mohawk Flora for three habitat types with growth-forms. See Fig. 2 for explanation of life-form symbols (p = parasitic plants; s = succulent plants). Very rare occurrences or extirpated species shown in parenthesis (-).

	dunes	Sandflats	playa	Growth form
Abronia villosa	D	S		TW
Achyronychia cooperi	D	S		TW
Allionia incarnata	D	S		TN
Amaranthus fimbriatus	D	S		TS
Amaranthus palmeri		S		TS
Ambrosia confertiflora		S		H
Ambrosia deltoidea	D	S		C
Ambrosia dumosa	D	S		C
Amsinckia tessellata	D	S		TW
Argemone gracilenta	D			H
Aristida adscensionis		S		TN
Aristida californica	D	S		H
Asclepias subulata		S		Ns
Astragalus insularis	D	S		TW
Astragalus nuttallianus	D	S		TW
Baccharis salicifolia			(P)	N
Baccharis sarothroides			(P)	N
Baileya pauciradiata	D	S		TW
Baileya pleniradiata	D	S		TN
Boerhavia erecta		S		TS
Boerhavia spicata	D	S		TS
Boerhavia wrightii		S		TS
Bouteloua aristidoides	D	S		TS
Bouteloua barbata	D	S		TS
Brassica tournefortii	D	S		TW
Camissonia boothii		S	(P)	TW
Camissonia californica	D	S		TW
Camissonia chamaenerioides		S		TW
Camissonia claviformis ssp. *peeblesii*	D	S		TW
Camissonia claviformis ssp. *Yumae*		S		TW
Carnegiea gigantea		(S)		Ms
Castela emoryi		S		M
Caulanthus lasiophyllus	D	S		TW
Chaenactis stevioides	D	S		TW
Chorizanthe brevicornu	D	S		TW
Chorizanthe rigida		S		TW
Cylindropuntia echinocarpa	D	S		Ns
Cryptantha angustifolia	D	S		TW
Cryptantha ganderi	D			TW
Cryptantha maritima		S		TW
Cryptantha micrantha	D			TW
Cuscuta umbellata	D	S		TSp
Dalea mollis	D	S		TN

TABLE 2. continued

	dunes	Sandflats	playa	Growth form
Datura discolor	?	S		TN
Dicoria canescens	D			TN
Dimorphocarpa pinnatifida	D			TW
Ditaxis serrata	D	S		TN
Dithyrea californica	D			TW
Echinocactus polycephalus		(S)		Cs
Ephedra trifurca	D	S		N
Eriastrum diffusum	D	S		TW
Eriastrum eremicum		S		TW
Eriogonum trichopes	D	S		TW
Eriophyllum lanosum		S		TW
Erodium texanum		S		TW
Eschscholzia glyptosperma		S		TW
Eschscholzia minutiflora	D	S		TW
Euphorbia abramsiana	D	S		TS
Euphorbia polycarpa	D	S		TN
Ferocactus wislizeni	(D)	S		Ns
Filago arizonica		S		TW
Festuca octoflora		S		TW
Fouquieria splendens		S		M
Funastrum cynanchoides		S		L
Geraea canescens	D	S		TW
Grusonia kunzei		(S)		Cs
Heliotropium convolvulaceum	D			TN
Heliotropium curassavicum			P	G
Hesperocallis undulata	D	S		G
Hoffmannseggia glauca			P	G
Isocoma acradenia		S	P	C
Kallstroemia californica	D	S		TS
Krameria erecta		S		C
Krameria grayi		S		N
Larrea divaricata	D	S		N
Lepidium lasiocarpum	D	(S)		TW
Linanthus bigelovii	D	S		TW
Loeseliastrum schottii	D	S		TW
Lupinus arizonicus	D	S		TW
Lycium parishii		S		N
Malacothrix glabrata	D			TW
Malvella sagittifolia			P	G
Marina parryi	D	(S?)		TN
Mentzelia albicaulis	D			TW
Mentzelia multiflora	D	S		TW
Mollugo cerviana	D			TS
Monoptilon bellioides	D	S	(P)	TW
Muhlenbergia microsperma		S		TN

TABLE 2. continued

	dunes	Sandflats	playa	Growth form
Nama hispidum	D	S	(P)	TW
Nemacaulis denudata	D			TW
Oenothera deltoides	D	S		TW
Oenothera primiveris	D	S		TW
Oligomeris linifolia	D	S	P	TN
Olneya tesota		S		M
Orobanche cooperi		S		TWp
Palafoxia arida	D	S		TN
Panicum alatum		S		TS
Parkinsonia florida		S		M
Parkinsonia microphylla		S		M
Pectis papposa	D	S		TS
Pectocarya heterocarpa	D	S		TW
Pectocarya platycarpa	D	S		TW
Phacelia ambigua		S		TW
Phoradendron californicum		S		Ep
Physalis lobata			P	H
Physaria tenella		S		TW
Plantago ovata	D	S	P	TW
Pleuraphis rigida	D	S		H
Populus fremontii			(P)	N
Proboscidea altheaefolia	D	S	P	G
Prosopis glandulosa	D	S	P	M
Psorothamnus emoryi	D			N
Rafinesquia neomexicana	D	S		TW
Schismus arabicus	D	S		TW
Sonchus asper	D	S		TW
Sphaeralcea ambigua		(S)	P	C
Sphaeralcea coulteri	D	S		TN
Stephanomeria schottii	D			TW
Streptanthella longirostris	D	S		TW
Stylocline micropoides	D	S		TW
Tamarix ramosissima			(P)	N
Tidestromia lanuginosa	D	S		TS
Tiquilia plicata	D	(S)		G
TOTALS: 122 species.	78	101	17	

species, representing 81% of the dune flora, one of the highest percentages of annuals among any regional flora. Of these dune ephemerals, 53 species, or 84% develop during the cool season (41 winter/spring and 12 non-seasonal species), which supports Shreve's (1951:127) statement that sand is a favorable soil for cool-season ephemerals. Non-seasonal ephemerals are those that can germinate and grow with sufficient soil moisture at any time of year (see Felger 2000). Variation in plant cover and dune vegetation is shown in Figs. 3–5.

TABLE 3. Average percent ground cover at three localities in the Mohawk Dunes, March 1996.

Species	E-side dune	E-side swale	W-side dune
Ambrosia dumosa	1.56	4.14	9.07
Aristida californica	0.00	0.89	1.28
Ephedra trifurca	0.97	1.12	1.30
Larrea divaricata	0.00	1.16	0.00
Pleuraphis rigida	3.35	1.41	3.50
Psorothamnus emoryi	0.89	0.24	0.08
Tiquilia plicata	0.01	0.00	0.01
Lupinus arizonicus	0.01	0.01	0.02
Total live ground cover %	6.77	8.95	15.25

Playa.—The main expanse of the playa consists of silty-clay soil riddled with deep fissures. Seventeen species were found on the playa and its margins. Three herbaceous root-perennials are abundant across the expanse of the playa: *Heliotropium curassavicum*, *Hoffmannseggia glauca*, and *Malvella sagittifolia*. Following the occasional times when the playa fills with water, *Sphaeralcea ambigua* and other herbaceous plants may become locally abundant. *Physalis lobata*, *Oligomeris linifolia*, and *Prosopis glandulosa* are locally common around the margin of the playa. The remaining species are uncommon in this habitat or on sandy soils at the playa margin. Four woody plants are known from one or few individuals that probably germinated during the exceptionally wet year of 1992–93: seep willow (*Baccharis salicifolia*), desert broom (*B. sarothroides*), cottonwood (*Populus fremontii*), and tamarisk (*Tamarix ramosissima*). The cottonwood and seep willow perished from drought by the end of 1994 and the tamarisk by June 1996.

Sand flats. Areas surrounding the dune field vary from rolling hills and low sand hummocks to occasionally extensive flats of sandy to silty-sand and clay-sand soils. These habitats, collectively called "sand flats," support 101 species within ca. 1 km of the dune margins (Table 2). Nearly 30% of these species were not found on the dunes.

Desert shrubs, namely creosotebush and the two bursages (*Ambrosia deltoidea* and *A. dumosa*) are the most common, widespread elements in the landscape. Several cacti and crucifixion thorn (*Castela emoryi*) are widely but thinly scattered across the landscape, and patchy areas of ocotillo (*Fouquieria splendens*), ratany (*Krameria erecta*), and several other perennials are locally prominent.

The sand flat habitats and vegetation grade into those of the dunes, and less noticeably into the surrounding valley plains and vegetation. But common shrubs such as creosotebush (*Larrea divaricata*) tend to be noticeably less dense on these sandy areas than the surrounding plains.



FIG. 3. Mohawk Dunes, during a "wet spring," 28 February 1998. *Oenothera deltoides* (white flowers) *Abronia villosa* (lavender-pink flowers), and *Pleuraphis rigida* (background). Looking eastward, Mohawk Mountains in background. Photo by Thomas R. Jones.



FIG. 4. Same view as Fig. 3, but during a drought year, 12 March 2002. The skeleton in foreground is the same *Oenothera deltoides* shown in Fig. 3 left foreground. Photo by Thomas R. Jones.



FIG. 5. Northern part of Mohawk Dunes looking eastward towards Mohawk Mountains, April 1998. *Abronia villosa* (forground) and *Mentzelia multiflora* (center forground). Photo by Charles Hedgcock.

Comparison to Other Dune Systems

In terms of plant diversity and species composition, the Mohawk Dunes, as expected, show the greatest affinity to other inland dune systems within the Sonoran Desert. Of these, the greatest similarity exists with dunes of the Gran Desierto, Sonora, the largest inland dune system in North America (5,000 km^2), centered approximately 70 km to the southwest of the Mohawk system (Felger 1980, 2000). The Pinta Sands of Cabeza Prieta National Wildlife Refuge, 38 km to the south are the closest dune system, but these dunes are only a northern extension of the Gran Desierto, being some 5 km from the northernmost dunes of that system. The Algodones dunes (709 km^2) of southeastern California, 90 km to the west, share many plants with the Mohawk system (*see* WESTEC Services 1977). Although no plant is endemic to the Mohawk Dune system alone, *Cryptantha ganderi*, *Dimorphocarpa pinnatifida*, and *Stephanomeria schottii* are endemic to dunes and adjacent sand flats of the Lower Colorado region of the Sonoran Desert.

The Mohawk system has among the highest species richness for its size

among southwestern dunes. The enormous Gran Desierto dune system has a flora of only 85 species (Felger 2000), amazingly few species for such an immense area. The relatively low species richness probably can be attributed to the low habitat diversity, extreme aridity, and harsh conditions brought about by moving sand. The Mohawk Dunes, with less than 2% of the area, supports a dune flora of 78 species (Table 2). The Algodones Dunes are reported to support a flora of 97 species (Bowers 1984, interpreting WESTEC Services 1977; this number, however, cannot be considered wholly accurate based on the available data). The Kelso Dunes in the eastern Mohave Desert support 75 species (Thorne et al. 1981), with some overlap with Mohawk Dune species. It is interesting to note the similarity in species richness among these diverse dune systems.

Species composition of the dominant dune vegetation in the Mohawk Dunes is similar to that of other Sonoran Desert dune systems (Felger 2000; Warren & Laurenzi 1987). Five species typically comprise at least 90% of the perennial vegetative cover on these systems, with *Ambrosia dumosa* and *Pleuraphis rigida* the most abundant, and *Psorothamnus emoryi*, *Ephedra trifurca*, and *Tiquilia plicata* as common associates.

Absent from the Mohawk Dunes are several dune-endemic species which are relatively common in the Gran Desierto and/or Yuma Dunes and Algodones Dunes, including *Asclepias erosa*, *Croton wigginsii*, *Drymaria viscosa*, *Eriogonum deserticola*, *Euphorbia platysperma*, *Helianthus niveus*, *Heterotheca thiniicola*, *Pholisma sonorae*, *Larrea divaricata* var. *arenaria*, *Palafoxia arida* var. *gigantea*, and *Triteleiopsis palmeri* (e.g., Felger 1980, 2000; Felger et al. 1997). This may be due to the relative isolation of the Mohawk Dunes. *Eriastrum eremicum*, found on the Mohawk Dunes is not present at the other dune systems; it is more characteristic of Arizona Upland locales and has its southwestern limits near the Mohawk Dunes.

Non-native Species

Five non-natives species, all native to the Old World, are recorded in the flora: *Brassica tournefortii*, *Mollugo cerviana*, *Schismus arabicus*, *Sonchus asper*, and *Tamarix ramosissima*. *Tamarix* is no longer present, and the remaining four occur on the dunes and all but *Mollugo* are also found on the sand flats. The *Brassica*, *Mollugo*, and *Schismus* are common and well established, while *Sonchus asper* is widely scattered but not common. Additional invasive weedy species undoubtedly will arrive on the scene. A number of non-native, weedy plants are conspicuously absent from the Mohawk flora but are common in nearby, mostly disturbed areas, e.g., buffelgrass (*Pennisetum ciliare* (L.) Link) and tumbleweed (*Salsola tragus* L.).

A flora with only 4% non-native species is remarkable, since the average for the Sonoran Desert is about 11.6% (Felger 2000; Wilson et al. 2002). It is not, however, unusual for regional dune systems. The Mohawk Dunes and the enor-

mous Gran Desierto dune system contain only the same four non-native species and the abundance patterns are likewise similar (see Felger 2000:21). The unusually low number of non-natives may be due to the uniqueness, isolation, and relatively undisturbed condition of the habitat.

Although competition between plants on dunes is reported to be negligible (Bowers 1982), *Brassica tournefortii* and *Schismus arabicus* certainly seem invasive and detrimental to native species (Felger 2000; Wilson et al. 2002). Their very rapid early growth seems to negatively affect native plants. On the Mohawk dunes as well as elsewhere in the Sonoran Desert (e.g., Felger 2000), *Brassica* rosette-leaves and *Schismus* plants spread over seedling and juvenile plants of the apparently slower-growing native ephemerals, possibly smothering or shading them out, or preventing their germination (Fig. 6).

ANNOTATED SPECIES ACCOUNTS

The flora is listed alphabetically by family, genus, and species. Accepted scientific names, including the variety (var.) or subspecies (subsp.), are in **bold**. Selected synonyms of scientific names are in *italics* within brackets [-]. Common names follow the scientific names, and when known are given in English and Spanish. Brief characterizations are provided for each species, including the usual flowering time and in most cases the general or most conspicuous color of the flower (flower color is often omitted for species with small, inconspicuous flowers). Growth and flowering, of course, is almost entirely linked to rainfall and soil moisture. During extended drought, such as 2001 and 2002, many plants fail to grow or flower. More detailed descriptions and distributional information can be found in many sources, e.g., Felger (1980, 2000), Hickman (1993), Kearney and Peebles (1960), Wiggins (1964), and the various contributions to the Vascular Plants of Arizona (Vascular Plants of Arizona Editorial Committee 2001).

The distributional information is based on field observations and for the most part verified with herbarium specimens primarily at the herbaria of the University of Arizona (ARIZ) and Arizona State University (ASU). Specimens cited are at ARIZ, unless otherwise indicated, and in many cases duplicates, especially those of Felger, are mostly at ASU, RSA, and SD. The five non-native species are indicated with an asterisk (*). The area had abundant spring rains during 1995 and 1998, and abundant summer rains during 1996 and 1997. In our opinion we likely encountered plants of nearly all of the ephemeral species present in the seed bank as well as all of the perennials.

AMARANTHACEAE - Amaranth Family

Amaranthus fimbriatus (Torr.) Benth. ex S. Watson. Fringed pigweed; *bledo, quelitillo*. Hot-weather annuals; flowers greenish and white. Sand flats and dunes. *Felger 97-63 et al.; Felger 96-138 & Turner.*

Amaranthus palmeri S. Watson. Carelessweed, pigweed; *bledo, quelite de las aguas*. Hot-weather annuals. Sand flats, especially near



FIG. 6. Northeast side of Mohawk Dunes looking northwest. *Schismus* in left foreground, *Abronia* (lavender-pink flowers), *Pleuraphis* in right foreground, dune swale in mid-distance, and dune slope in background with *Larrea* and *Abronia*. April 1998. Photo by Charles Hedgcock.

the south end of the dune field. *Felger 97-79 et al.*

Tidestromia lanuginosa (Nutt.) Standl. subsp. **eliassoniana** Sanchez-del Pino & Flores Olvera. Honeysweet; *hierba ceniza, hierba lanuda*. Hot-weather annuals; flowers yellow. Widespread and common, sand flats and dunes. *Felger 97-71 et al.; Felger 96-149 & Turner.*

ASCLEPIADACEAE - Milkweed Family

Asclepias subulata Decne. Desert milkweed, reedstem milkweed; *jumete, mata candelilla*. Perennials with multiple, semi-succulent stems; flowering during warmer months; flowers waxy, cream- and yellow-white. Occasional in washes in sand flats near north side of dune field. *Turner s.n., 12 Nov 2001.*

Funastrum cynanchoides (Decne.) Schlt. var. **hartwegii** (Vail) Krings [*Sarcostemma cynanchoides* Decne. subsp. *hartwegii* (Vail) R.W. Holm; *Funastrum heterophyllum* (Engelm.) Standley]. Climbing milkweed; *güirote*. Perennial vines; flowering at various seasons; flowers maroon and white. Occasional in washes in sand flats near the northern part of the dunes. *Felger & Turner*, 24 Sep 1996, observation.

ASTERACEAE - Daisy or Composite Family

Ambrosia confertiflora DC. Slimleaf ragweed; *estafiate*. Herbaceous perennials; flowering late spring and in fall. Occasional in depressions in sand flats near the dunes. *Felger 97 77 et al.*

Ambrosia deltoidea (Torr.) W.W. Payne. Triangle-leaf bursage; *chamizo forrajero*. Small shrubs. Common on dunes, sand flats, and playa margins. Summer dormant. *Felger 96 169 & Turner; Reina-G. 96-213 & Van Devender.*

Ambrosia dumosa (A. Gray) W.W. Payne. White bursage; *chamizo*. Small shrubs; flowering September-April. Summer-dormant, new leaves and flowers may appear as early as September. Very common on sand flats and dunes including higher dunes. *Felger 97-66 et al.; Felger 96-127 & Turner; Reina-G. 96-215 & Van Devender.*

Baccharis salicifolia (Ruiz & Pav.) Pers. [*B. glutinosa* Pers.]. Seep willow; *batamote*. Leafy shrubs. About ten plants, mostly 2-2.5 m tall, along the southern edge of the playa apparently grew during the exceptionally wet year of 1992-1993, and perished by the end of 1994. *Felger 96-154 & Turner.*

Baccharis sarothroides A. Gray. Desertbroom; *escoba amargo, romerillo*. Broomlike shrub. One individual, ca. 2 m tall, at northeast margin of playa. *Felger 96-150 & Turner.*

Baileya pauciradiata Harv. & A. Gray ex A. Gray. Few-flowered desert marigold. Spring annuals; flowers yellow. Dunes and sand flats. *Reichenbacher 601; Salywon et al. 988* (ASU); *Turner 95-26.*

Baileya pleniradiata Harv. & A. Gray ex A. Gray. Woolly desert marigold; *tecomblate*. Annuals, mostly in spring, sometimes with summer rains; flowers yellow. Dunes and sand flats. *Felger 98-56 & Evans; Salywon et al. 987* (ASU); *Turner 95-25, 95-30.*

Chaenactis stevioides Hook. & Arn. Desert pincushion. Cool-season annuals; flowers white or cream, pink in bud. Dunes, especially lower dunes, and sometimes on sand flats. *Felger 98-58 & Evans; Goldberg 77-87; Turner 95-5.*

Dicoria canescens A. Gray subsp. **canescens**. Bugseed. Annuals; germinating at least with spring rains, their numbers variously reduced by late-spring and early summer drought, recorded fully leafed-out in August, and variously flowering from late October through December; plants often robust to 1 m tall and becoming tumbleweeds after seeds ripen. Seedlings and juvenile plants quickly produce a deep taproot and have narrow, elongated leaves, the older plants produce broad and shorter leaves. Restricted to dunes, especially moving sands of higher dunes. On 24 November 1994, Turner observed plants in full bloom, abuzz with honeybees but no native bees; the honeybees probably were gathering pollen since the plants are presumably wind-pollinated. On 23 June 1995, Turner found clipped stems and leaves scattered around stripped stems—evidence of herbivory by kangaroo rats (*Dipodomys* sp.). *Felger 98-59 & Evans; Reichenbacher s.n., 7 Mar 1980; Turner 94-2.*

Eriophyllum lanosum (A. Gray) A. Gray. Woolly daisy. Small, cool-season annuals; disk flow-

ers yellow, rays white. Sand flats. *Felger 98-91 & Evans.*

Filago arizonica A. Gray. [*Logfia arizonica* (A. Gray) Holub]. Arizona fluffweed. Small, cool-season annuals. Low areas in sand flats. *Felger 98-93 & Evans.*

Geraea canescens Torr. & A. Gray. Desert sunflower, desert gold. Coarse spring annuals; flower heads sunflower-like, bright yellow. Dunes and sand flats. *Goldberg 77-89; Turner 95 27.*

Isocoma acradenia (Greene) Greene var. **acradenia** [*Haplopappus acradenius* (Greene) S.F. Blake]. Alkali goldenbush. Small shrubs; flowering various seasons, at least in spring and fall; flowers yellow. Occasional and localized at the playa margin and sand flats at roadsides. *Felger 96-143 & Turner, 96 155; Reina-G. 96-214 & Van Devender.*

Malacothrix glabrata (A. Gray ex D.C. Eaton) A. Gray [*M. californica* DC. var. *glabrata* A. Gray ex D.C. Eaton] Smooth desert-dandelion. Spring annuals; flower heads white with a pale yellow center. Dune slopes and higher dunes, scattered to sometimes seasonally common. *Felger 98-60 & Evans; Reichenbacher 603; Turner 95-6.*

Monoptilon bellioides (A. Gray) H.M. Hall. Desert star. Small, spring annuals; rays white, turning pale lavender with age, the disk yellow. Sand flats and sometimes on lower dunes; occasional at playa margin. *Felger 98-61 & Evans, 98-96; Turner 95-21.*

Palafoxia arida B.L. Turner & M.I. Morris var. **arida**. Spanish needles. Non-seasonal annuals; flowers white to pink with purple anthers. Sand flats and dunes at all elevations. Some of the larger, robust plants on the dunes approach var. *gigantea* (M.E. Jones) B.L. Turner & M.I. Morris in having larger flower heads and achenes. *Felger 98-4 et al.; Felger 96-139 & Turner; Turner 95-4.*

Pectis papposa Harv. & A. Gray var. **papposa**. Desert chinchweed; *manzanilla del coyote.* Hot-weather annuals; herbage pungently aromatic; flowers bright yellow. Sand flats and dunes. Highly variable in size, drought stressed plants can mature with a single flower head. *Felger 97-56 et al., 97-72; Felger 96-134 & Turner.*

Rafinesquia neomexicana A. Gray. Desert chicory. Spring annuals; flowers white. Dunes, especially dune slopes and swales, also lower dunes and sand flats; mostly growing through small shrubs such as *Ambrosia dumosa. Felger 98-85 & Evans; Felger 98-12 et al.*

***Sonchus asper** (L.) Hill subsp. **asper**. Spiny sowthistle; *chinita.* Winter-spring annuals; flowers pale yellow. Occasional and widely scattered in natural areas such as small arroyos and depression on sand flats, dune swales, lower dunes, and rarely on higher dunes. *Felger 98-62 & Evans, 98-95.*

Stephanomeria schottii (A. Gray) A. Gray. Schott's wire-lettuce. **Fig. 7.** Late spring annuals; flowers white tinged with violet. Seasonally abundant and widespread on dunes at all elevations and also low stabilized dunes of the nearby San Cristobal Valley. *Burgess 5067; Felger 98-16 et al.; Felger 98-63 & Evans; Reichenbacher 596; Turner 95-14.* San Cristobal Valley dunes, *Anderson 98-40, 98-54* (ASU).

Endemic to dunes and sand flats in the Gran Desierto in northwestern Sonora and southwestern Arizona in Yuma County (Felger 2000, Lehto 1979). This species has a Global Heritage Status Rank of G2 (imperiled globally).

Stylocline micropoides A. Gray. Desert neststraw. Small, spring annuals. Locally and seasonally common in swales and depressions among dunes, and sometimes on surrounding sand flats. *Felger 98-83 & Evans.*

BORAGINACEAE Borage Family

Amsinckia tessellata A. Gray. Checker fiddleneck. Cool-season annuals; flowers yellow. Common on dunes and sand flats. *Turner 95-13.*

Cryptantha angustifolia (Torr.) Greene. Narrowleaf cryptantha, desert cryptantha. Cool-season annuals; corollas white with a yellow throat. Widespread across the dunes and sand flats; one of the most common and ubiquitous spring annuals in the region. *Turner 95-12.*

Cryptantha ganderi I.M. Johnst. Cool-season annual, sometimes locally common; flowers minute, white; fruits with 2 smooth nutlets.



FIG. 7. *Stephanomeria schottii*, dunes, early morning, May 8, 1999. Photo by Charles Hedgcock.

Lower dunes and steep dune slopes; often beneath shrubs such as *Ephedra*. *Felger 98-64 & Evans*.

Dunes and sand flats of the Gran Desierto in northwestern Sonora, and extending into adjacent southwestern Arizona on the Pinta Sands in Cabeza Prieta National Wildlife Refuge, and disjunct on the Mohawk Dunes, and similar habitats in southeastern California and Baja California. First confirmed for Arizona in 1993 (Felger 2000; Felger et al. 1993). This species has a Global Heritage Status Rank of G2 (imperiled globally).

Cryptantha maritima (Greene) Greene [includes var. *maritima* and var. *pilosa* I.M. Johnst.]. White-haired cryptantha. Cool-season annuals; corollas white. Widely scattered on sand flats. *Felger 98-99 & Evans*.

Cryptantha micrantha (Torr.) I.M. Johnst. subsp. **micrantha**. Dwarf cryptantha. Cool-season annuals; flowers minute, white. Widespread on dunes at all elevations. *Felger 96-164 & Turner*.

Heliotropium convolvulaceum (Nutt.) A. Gray var. **californicum** (Greene) I.M. Johnst. Morning-glory heliotrope. Non-seasonal annuals, mostly germinating and growing during warm weather with sufficient soil moisture; flowers white and showy. Seasonally scattered on dunes. *Van Devender 92-644*.

Heliotropium curassavicum L. [The plants are var. *oculatum* (A. Heller) I.M. Johnst. ex Tidestr., but the variety is probably not worthy of recognition, see Felger 2000]. Alkali heliotrope; *hierba del sapo*. Semi-succulent perennial herbs or facultative annuals; herbage frost-sensitive; corollas white, the center yellow and turning purplish with age. Widespread across the playa, sometimes locally abundant. *Felger 96-152 & Turner; Reina-G. 96-211 & Van Devender; Turner 94-1*.

Pectocarya heterocarpa (I.M. Johnst.) I.M. Johnst. Mixednut comb-bur. Cool-season annuals; corollas white with a yellow center. Widespread and common, dunes and sand flats. *Felger 98-65 & Evans*.

Pectocarya platycarpa (Munz & I.M. Johnst.) Munz & I.M. Johnst. Broadwing comb-bur. Cool-season annuals; flowers white. Dunes and sand flats. *Felger 98-90A & Evans*.

Tiquilia plicata (Torr.) A.T. Richardson. Fanleaf crinklemat. Perennial herbs from deep, thick and black roots; flowering spring and summer; corollas lavender. Mostly on moving dunes, occasional on low sand hills on sand flats. *Felger 97-70 et al.; Felger 96-136 & Turner; Reichenbacher 599*.

BRASSICACEAE (CRUCIFERAE) - Mustard Family

***Brassica tournefortii** Gouan. Sahara mustard, wild turnip; *mostaza*. Cool-season annuals; plants highly variable in size; flowers pale yellow and apparently selfing (Felger 2000). Widespread and especially abundant on dunes during years of high winter spring rains; sand flats and dunes including highest dunes. Larger plants with basal rosette leaves each to 72 cm long, these leaves spreading close to ground and often covering other spring annuals. The leaves are bitter tasting except those of very small, young plants. *Felger 98 2 et al.; Turner 95-10*.

Caulanthus lasiophyllus (Hook. & Arn.) Payson. Cool-season annuals; flowers minute, white to pinkish. Mostly in swales and on north-facing dune slopes, locally common; also sand flats in washes and swales, mostly at the base of shrubs. *Felger 98-67 & Evans*.

Dimorphocarpa pinnatifida Rollins [*Dithyrea wislizenii* Engelm., in part]. Dune spectaclepod. **Fig. 8.** Cool-season annuals, sometimes more than 1 m across; flowers white and fragrant. Dunes, especially the higher dune crests. Endemic to dunes and sand flats in Yuma County and the Gran Desierto in northwestern Sonora. *Felger 98-6 et al.; Salywon et al. 985; Turner 95-7*. San Cristobal Valley dunes, *Anderson 98-37* (ASU).

Dithyrea californica Harv. Spectaclepod. Cool-season annuals; flowers cream-colored, highly fragrant. Widespread across the dunes, especially lower dunes and slopes. *Felger 98-5 et al.; Salywon et al. 984* (ASU).

Lepidium lasiocarpum Nutt. ex Torr. & A. Gray. Sand peppergrass. Cool-season annuals; herbage peppery-tasting; flowers minute, white. Widespread, mostly on lower dunes and swales, and expected on sand flats. *Felger 98 3 et al.*



FIG. 8. *Dimorphotheca pinnatifida*, dunes, April 1998. Photo by Charles Hedgcock.

Physaria tenella (A.Nels.) O'Kane & Al-Shehbaz [*Lesquerella tenella* A. Nels.]. Desert bladderpod. Cool-season annuals; flowers bright yellow. Sand flats, often growing through bursage (*Ambrosia* spp.). *Felger 98-17 et al.; Felger 98-98 & Evans.*

Streptanthella longirostris (S. Watson) Rydb. Longbeak twistflower. Cool-season annuals; herbage often glaucous and sometimes semisucculent; flowers minute, pale yellowish-white. Widely scattered across dunes, especially swales and north facing slopes, and less common on higher dunes; also sand flats, especially at the base of shrubs. *Felger 98-66 & Evans; Felger 98-7 et al.; Salywon et al. 983* (ASU).

CACTACEAE - Cactus Family

Carnegiea gigantea (Engelm.) Britton & Rose. Saguaro. Columnar cactus; one individual ca. 6 m tall with two large branches. Early summer. Sand flat on east side of dunes.

Cylindropuntia echinocarpa (Engelm. & J.M. Bigelow) F.M. Knuth [*Opuntia echinocarpa* Engelm. & J.M. Bigelow; *O. wigginsii* L.D. Benson]. Silver cholla. Small chollas to 1+ m tall; April; flowers silvery white with green filaments. Mostly lower dunes and swales, especially with harder soils, and sand flats, widely scattered, mostly in small colonies. *Felger & Turner*, 24 Sep 1996, observation.

Echinocactus polycephalus Engelm. & J.M. Bigelow var. **polycephalus**. Many-headed barrel cactus. Multiple-headed, mound-forming barrel cactus; July; flowers yellow. One mature plant (14 living stems) on creosotebush flat near west side of dunes. *Turner*, 27 Jul 1995, photo.

Ferocactus wislizeni (Engelm.) Britton & Rose. Barrel cactus; *biznaga*. Unbranched barrel cactus to ca. 1.5 m tall; flowers orange to red-orange, at least August and September; fruits yellow and fleshy, ripe in late summer and early fall. Occasional and widely scattered on sand flats, especially west side of dunes, and rare on dunes. *Felger 97-52 et al.; Felger 96-165 & Turner, 96-171.*

Grusonia kunzei (Rose) Pinkava [*Opuntia kunzei* Rose. *O. stanleyi* Engelm. ex B.D. Jackson var. *kunzei* (Rose) L.D. Benson]. Desert club cholla. Large club cholla; flowers yellow, summer. One colony, mostly senescent, on low sand hummock on sand flat near southeast margin of dune field. *Felger & Turner*, 25 Sep 1996, observation.

CARYOPHYLLACEAE Pink Family

Achyronychia cooperi Torr. & A. Gray. Sandmat, frostmat. Cool-season annuals; flowers papery white like the stipules. Dunes, especially lower dunes and also on highest dunes and sand flats. *Felger 98-68 & Evans; Salywon et al. 991* (ASU).

CONVOLVULACEAE – Morning-Glory Family

Cuscuta umbellata Kunth. Desert dodder. Warm-season annuals, stems twining; flowers white; parasitic on *Boerhavia* spp. Occasional; dunes and sand flats. *Felger 97-59 et al.*

EPHEDRACEAE - Ephedra Family

Ephedra trifurca Torr. ex S. Watson. Longleaf jointfir, Mormon tea; *canutillo, tepopote*. Robust, spreading shrubs to ca. 1.5 m tall, the trunks and major limbs thick and heavy. Twigs with 3 elongated scale leaves at each node. Dunes and sand flats. Pollen cones mature in March; seeds later in spring. *Felger 98-52 & Evans; Reina-G. 96-208 & Van Devender; Salywon et al. 986* (ASU).

EUPHORBIACEAE - Spurge Family

Ditaxis serrata (Torr.) A. Heller var. **serrata** [*Argythamnia serrata* (Torr.) Müll. Arg.]. Non-seasonal annuals; flowers inconspicuous, green and white. Dunes and sand flats. *Felger 97-51 et al., 98-21b; Felger 96-135 & Turner.*

Euphorbia abramsiana L.C. Wheeler [*Chamaesyce abramsiana* (L.C. Wheeler) Koutnik]. *Golondrina*. Hot-weather annuals; petal like appendages absent or minute. Sand flats and dunes. *Felger et al. 97-57, 97-78 et al.; Felger 96-128 & Turner.*

Euphorbia polycarpa Benth. [*Chamaesyce polycarpa* (Benth.) Millsp.; *E. polycarpa* var. *hirtella* Boiss.]. Desert spurge; *golondrina*. Non-seasonal annuals, but most common during spring; petal-like appendages white, sometimes reduced or absent. Sand flats and

dunes. *Felger 97 53 et al., 97-69; Felger 96 130 & Turner, 96-144.*

FABACEAE (**LEGUMINOSAE**) - Legume Family

Astragalus insularis Kellogg var. **harwoodii** Munz & McBurney ex Munz. Sand locoweed. Cool-season annuals; flowers rose-lavender and white. Dunes, especially lower dunes, and sand flats. *Felger 98-70 & Evans; Turner 95-24.*

Astragalus nuttallianus DC. var. **imperfectus** (Rydb.) Barneby. Smallflowered milkvetch. Cool-season annuals; flowers blue and white. Widely scattered; dunes, mostly swales and lower dunes, and sand flats. *Felger 98-74 & Evans; Felger 98-1 et al.*

Dalea mollis Benth. Silky dalea. Non-seasonal annuals. Dunes, especially lower dunes and dune slopes, and sand flats. *Felger 98-80 & Evans; Reichenbacher 437; Turner 95-27.*

Hoffmannseggia glauca (Ortega) Eifert [*Caesalpinia glauca* (Ortega) Kuntze]. Hog potato; *camote de ratón*. **Fig. 9.** Perennial herbs from deep-seated tuberous roots; flowering non-seasonally with warm weather and sufficient soil moisture; flowers yellow. Common across the playa. *Felger 98-50 & Evans; Reina-G. 96-212 & Van Devender; Turner 95-23.*

Lupinus arizonicus (S. Watson) S. Watson [*L. arizonicus* subsp. *sonorensis* J.A. Christian & D.B. Dunn] Arizona lupine; *lupino*. Cool-season annuals, flowers lavender-pink. Widespread and common, lower to higher dunes, slopes, and dune swales, and sand flats. Plants often ravaged by caterpillars of the painted lady butterfly (*Vanessa cardui*) and the white-lined sphinx moth (*Hyles lineata*; **Fig. 10**). *Felger 98-79 & Evans; Salywon et al. 993* (ASU); *Turner 95-3.*

Marina parryi (Torr.& A.Gray ex A.Gray) Barneby [*Dalea parryi* Torr. & A. Gray ex A. Gray]. Non-seasonal annuals (sometimes short-lived herbaceous perennials elsewhere); flowers dark blue. Dunes and expected on sand flats. *Reichenbacher*, 7 Mar 1980, observation.

Olneya tesota A.Gray. Ironwood; *palo fiero*. Trees ca. 6+ m tall; late April and May; flowers lavender-pink. Washes in sand flats near the northeast and southeast parts of dune field. *Felger & Turner*, 25 Sep 1996, observation.

Parkinsonia florida (Benth. ex A. Gray) S. Watson [*Cercidium floridum* Benth. ex A. Gray]. Blue palo verde; *palo verde*. Trees, ca. 5+ m tall; April, flowers bright yellow. Large wash in sand flats near north end of dune field. *Turner s.n., 12 Nov 2001.*

Parkinsonia microphylla Torr. [*Cercidium microphyllum* (Torr.) Rose & I.M. Johnst.]. Littleleaf palo verde; *palo verde*. Small trees; April and May; flowers pale yellow with a white banner. Scattered along washes in sand flats ca. 1-2 km from northeast and southwest margins of the dune field. *Felger & Turner*, 24 Sep 1996, observation.

Prosopis glandulosa Torr. var. **torreyana** (L.D. Benson) M.C. Johnst. Western honey-mesquite; *mezquite*. Large shrubs to small trees; flowering April and often sporadically through the summer and fall; flowers yellow. Playa margins and washes in sand flats in the surrounding desert, and rarely on dunes including dune swales and crests. Mesquites in the region are intermediate with *P. velutina* Wooton; most leaves have one pair of pinnae, as in *P. glandulosa*, although occasional leaves have two pairs as in *P. velutina*, and the herbage is often moderately pubescent as in *P. velutina* (see Felger 2000). *Felger 96-165 & Turner; Reina-G. 96-207 & Van Devender.*

Psorothamnus emoryi (A. Gray) Rydb. var. **emoryi** [*Dalea emoryi* A. Gray]. Emory indigobush. Shrubs to ca. 1 m tall; flowering after rains, spring and summer; flowers purple and white. Very common on dunes at all elevations and to margins of sand flats. *Felger 96 141 & Turner, 96-163; Felger 97-65 et al.; Reina-G. 96-209 & Van Devender.*

FOUQUIERIACEAE - Ocotillo Family

Fouquieria splendens Engelm. subsp. **splendens**. Ocotillo. Shrubs; spring; flowers red-orange. Common on sand flats at northeast margin of dune field. *Felger & Turner*, 24 Sep 1996, observation.

GERANIACEAE - Geranium Family

Erodium texanum A. Gray. False filaree, desert stork-bill. Cool-season annuals; flowers pink-purple. Sand flats. *Felger 98-18 et al.*



Fig. 9. *Hoffmannseggia glauca*, on the playa, June 1994. Photo by Charles Hedgcock.

HYDROPHYLLACEAE - Waterleaf Family

Nama hispidum A. Gray. Bristly nama. **Fig. 11.** Cool-season annuals; flowers lavender. Dunes and swales, playa margins, and sand flats. *Felger 98-71 & Evans; Turner 95-16.*

Phacelia ambigua M.E. Jones [*P. crenulata* Torr. ex S. Watson; *P. crenulata* var. *ambigua* (M.E. Jones) J.F. Macbr.]. Desert heliotrope. Cool-season annuals; flowers lavender-purple. Sand flats. *Felger 98-89 & Evans; Turner 95-9.*

KRAMERIACEAE Ratany Family

Krameria erecta Willd. ex Schult. [*K. parvifolia* Benth.]. Range ratany. Dwarf shrubs; flowering at least spring and late summer; flowers bright magenta-purple. Widespread on sand flats. *Felger 96-148 & Turner, 96-172.*

Krameria grayi Rose & Painter. White ratany; *cósahui*. Shrubs; flowering various seasons; flowers magenta-purple. Sand flats; apparently rare or at least uncommon in the Mohawk Dune region although common in nearby areas. *Felger 96-147 & Turner.*

LILIACEAE (sensu lato) - Lily Family

Hesperocallis undulata A. Gray. Ajo lily, desert lily; *ajo silvestre*. **Fig. 12.** Perennials from a large, single bulb; flowering stalks sometimes reaching 1.5 m in height; February-April (early May); flowers white, 6-8 cm wide when fully open, opening late afternoon, closing with daytime heat of the next morning. Widespread, dunes and sand flats; best developed on dunes including highest dunes. *Felger 98-72 & Evans.*

LOASACEAE - Stick Leaf Family

Mentzelia albicaulis Douglas ex Hook. White-stem blazingstar. Cool-season annuals; flowers small with uniformly bright-yellow petals. Dunes and especially in swales. *Felger 98 82 & Evans.*



FIG. 10. *Hyles lineata* eating *Lupinus arizonicus*, April 1998. Photo by Charles Hedgcock.



Fig. 11. *Nama hispidum* with *Schismus* above and *Pectocarya heterocarpa* below, April 1998. Photo by Charles Hedgcock.

Mentzelia multiflora (Nutt.) A.Gray. Blazingstar. Robust, cool-season annuals; flowers moderately large, yellow. Dunes and sometimes on sand flats. *Salywon & Shohet 558* (ASU); *Turner 92-2, 95-5.*

MALVACEAE Mallow Family

Malvella sagittifolia (A.Gray) Fryxell [*Sida lepidota* A.Gray var. *sagittifolia* A.Gray]. Narrowleaf mallow. Perennial herbs from deeply seated roots, spreading by rhizomes; growing and flowering with sufficient soil moisture any time of year except the coldest months. Open area of playa. *Reina-G. 96 210 & Van Devender; Salywon et al. 999* (ASU); *Turner 95-18.*

Sphaeralcea ambigua A.Gray subsp. **ambigua**. Desert globemallow. Perennial subshrubs; flowering various seasons, especially spring; flowers orange. Seasonally abundant at playa margins, and occasional on sand flats at northeast side of dunes. *Felger 98-21 et al.; Turner s.n, 19 Apr 1998.*

Sphaeralcea coulteri (S. Watson) A. Gray var. **coulteri**. Annual globemallow; *mal de ojo*. Non-seasonal annuals, generally growing with winter-spring rains, highly variable in size, several cm to 1.5 m tall; flowers orange. Seasonally abundant, lower dunes including swales, and sand flats. *Felger 98-75 & Evans; Turner 95-17.*



FIG. 12. *Hesperocallis undulata*, flowers ca. 6–7 cm long, April 1998; note the lower leaves in a basal rosette close to the sand. Photo by Charles Hedgcock.

MARTYNIACEAE - Devil's Claw Family

Proboscidea altheaefolia (Benth.) Decne. Devil's claw; *gato, uña de gato, torito*. **Fig. 13.** Perennial herbs from a single tuberous root, growing and flowering during warmer months; flowers showy, bright yellow with white and orange markings. Widely scattered; dunes, sand flats, and playa. *Felger 97-63 et al.; Felger 96-146 & Turner.*

MOLLUGINACEAE - Carpetweed Family

***Mollugo cerviana** (L.) Sér. Thread-stem carpetweed; Indian chickweed. Small, hot-weather annuals; flowers minute, green and whitish. Seasonally common on dunes. *Felger 97-62 et al., 97-81.*

NYCTAGINACEAE - Four-O'clock Family

Abronia villosa S. Watson var. **villosa**. Sand verbena. Cool-season annuals; flowers lavender-pink and fragrant. Widespread and often seasonally abundant on dunes and sand hummocks across the Mohawk Valley, often producing spectacular floral displays in spring. *Salywon et al. 996* (ASU); *Turner 95-15.*

Allionia incarnata L. Trailing windmills, trailing four o'clock. Non-seasonal annuals, mostly growing during warmer months, with trailing stems (elsewhere short lived perennials); violet-rose or magenta. Dunes and sand flats. *Felger 97-54 et al.; Felger 96-132 & Turner.*

Boerhavia erecta L. var. **intermedia** (M.E. Jones) Kearney & Peebles [*B. intermedia* M.E. Jones; *B. triqueta* S. Watson]. Spiderling. Hot-weather annuals; flowers white to pale pink. Sand flats. *Felger 97-75 et al.*

Boerhavia spicata Choisy [*B. spicata* var. *palmeri* S. Watson; *B. coulteri* (Hook. f.) S. Watson]. Hot-weather annuals; flowers white to pale pink. Sand flats and dunes; sometimes very common. The plants are often ravaged by white-lined sphinx moth caterpillars (*Hyles lineata*). *Felger 97-55 et al.; Felger 96 166 & Turner.*

Boerhavia wrightii A. Gray. Largebract spiderling. Hot-weather annuals; flowers pinkish white to pink. Sand flats, often localized in small depressions. *Felger 97-76 et al.*

ONAGRACEAE - Evening Primrose Family

Camissonia boothii (Douglas) P.H. Raven subsp. **condensata** (Munz) P.H. Raven. Woody bottle-washer. Cool-season annuals; flowers white. Skeletons may persistent for one year or more. Mostly in localized colonies on sand flats and occasionally at the playa edge. *Felger 98-92 & Evans; Felger 96-157 & Turner.*

Camissonia californica (Torr. & A. Gray) P.H. Raven. Cool-season annuals; flowers yellow, changing to orange and drying pink. Localized in dune swales and sometimes on sand flats, especially along small washes. *Felger 98-87 & Evans.*

Camissonia chamaenerioides (A. Gray) P.H. Raven. Longcapsule evening-primrose. Cool-season annuals; flowers pink. Sand flats, generally along small washes or in shallow depressions. This is the smallest-flowered evening primrose in the Sonoran Desert; the floral structure and modifications are characteristic of self-pollinated flowers. *Felger 98-100 & Evans.*

Camissonia claviformis (Torr. & Frém.) P.H. Raven subsp. **peeblesii** (Munz) P.H. Raven. Cool-season annuals. Corollas white to pink with maroon-brown inside the tube. Sand flats, lower dunes, dune swales and slopes. *Felger 98-14 et al.; Felger 98-94 & Evans; Turner 95-31.*

Camissonia claviformis subsp. **yumae** (P.H. Raven) P.H. Raven. Cool-season annuals. Corollas yellow with maroon-brown inside the tube. Sand flats near the dune field. *Felger 98-94 & Evans.* Although two subspecies occur in the area, they apparently do not occur intermixed and plants with intermediate features have not been found.

Oenothera deltoides Torr. & Frém. subsp. **deltoides**. Dune evening-primrose, white evening-primrose, devils' lantern. Cool-season annuals; flowers large and white. The dry skeletons persist for one or more years. Sand flats and dunes. Often common and showy. *Turner 95-8.*

Oenothera primiveris A. Gray subsp. **primiveris**. Yellow desert evening-primrose. Cool-season annuals; flowers large and yellow. The dry skeletons may persist for several years. Mostly lower dunes, also swales



Fig. 13. *Proboscidea altheaefolia*, dunes, August 1996. Photo by Charles Hedgcock.

and sand flats. *Felger 98-84 & Evans; Felger 96-158 & Turner.*

OROBANCHACEAE - Broomrape Family

Orobanche cooperi (A. Gray) A. Heller. Desert broomrape; *flor de tierra*. Cool-season annuals parasitic on *Ambrosia* spp.; stems thick and succulent; flowers purple and white, the throat often marked with yellow. Although the plants may appear perennial because of their robust habit, they are apparently annuals (George Yatskievych, pers. comm.). Sand flats. *Goldberg 77-91; Turner s.n., 2 May 1998.*

PAPAVERACEAE - Poppy Family

Argemone gracilenta Greene. Sonoran pricklypoppy, fried-egg poppy; *cardo*. Short-lived perennials to 80+ cm tall, or probably often facultative annuals in the flora region; flowering late spring and in nearby areas sometimes sporadically through the summer; flowers large, with white petals and numerous yellow stamens. Lower dunes and dune swales, scattered and seldom common. *Felger 98-77 & Evans.*

Eschscholzia glyptosperma Greene. Gold poppy. Cool-season annuals. Locally common during years of exceptional winter-spring rain; flowers yellow-orange. Sand flats, especially near the northern and eastern part of the dune field. *Felger 98-88 & Evans; Salywon et al. 982* (ASU); *Turner 95-23.*

Eschscholzia minutiflora S. Watson. Little gold-poppy. Cool-season annuals; flowers yellow-orange. Dunes and locally on sand flats. *Turner 95-33.*

PLANTAGINACEAE - Plantain Family

Plantago ovata Forssk. [*P. insularis* Eastw., not *P. insularis* (Grenier & Godron) Nyman; *P. fastigiata* E. Morris; *P. insularis* var. *fastigiata* (E. Morris) Jeps.]. Woolly plantain, Indian-wheat; *pastora*. Winter-spring ephemerals, highly variable in size depending on soil moisture; flowers straw-colored. Widespread across dunes and sand flats, but especially lower dunes and swales, and sometimes on the playa. *Felger 98-1 et al.*; *Goldberg 11 88*; *Salywon et al. 998* (ASU); *Turner 95-19*.

POACEAE (GRAMINEAE) Grass Family

Aristida adscensionis L. Sixweeks threeawn; *zacate tres barbas*. Non-seasonal annuals. Sand flats. *Felger 96-145 & Turner*.

Aristida californica Thurb. var. **californica**. California threeawn; *tres barbas de california*. Tufted perennials, also flowering in first season during summer. Widespread, sand flats and especially common on dunes. *Felger 98-10 et al.*; *Felger 96-142 & Turner, 96-167, 96-170*.

Bouteloua aristidoides (Kunth) Griseb. Sixweeks needle grama; *aceitilla, navajita*. Summer annuals. Sand flats and dunes; widespread and common. *Felger 97 80 et al., 97 67*; *Felger 96 140 & Turner*.

Bouteloua barbata Lag. Six weeks grama; *navajita, zacate liebrero*. Summer annuals. Sand flats and dunes. *Felger 97-68 et al.*; *Felger 96 131 & Turner, 96-131*.

Festuca octoflora Walter [*Vulpia octoflora* (Walter) Rydb.; *F. octoflora* var. *hirtella* Piper]. Sixweeks fescue, eight-flowered fescue. Cool season annuals; diminutive grass. Sand flats, mostly beneath shrubs and in small depressions at the northeast side of the dune field. *Felger 98-97 & Evans*.

Muhlenbergia microsperma (DC.) Trin Littleseed muhly; *liendrilla chica*. Non-seasonal annuals. Generally beneath shrubs in small washes or depressions in sand flats. *Felger 98-18 et al.*

Panicum alatum Zuloaga & Morrone var. **minus** (Andersson) Zuloaga & Morrone. Summer annuals. Shallow depression in sand flats at edge of playa. *Felger 98-8 et al.* This species is indistinguishable from the common and widespread *P. hirticaule* except for consistent spikelet characters. In western Sonora and southwestern Arizona *P. alatum* has a limited and localized distribution, characteristically in playas and similar habitats with temporary standing water and clayish soils, while *P. hirticaule* is widespread and common in many habitats throughout the region (Felger 2000). They do not seem to occur together.

Pleuraphis rigida Thurb. [*Hilaria rigida* (Thurb.) Benth. ex Scribn.]. Big galleta; *galleta grande, toboso*. Large, tufted or bushy perennials. Widespread and abundant, dunes and sand flats. *Felger 96 137 & Turner*.

***Schismus arabicus** Nees. Arabian schismus. Cool-season annuals. Widespread and seasonally abundant on sand flats and dunes, and especially common on dune slopes and swales. The plants at first grow close to the ground, apparently preventing the growth of native ephemerals (see Felger 2000). *Turner 95-11*.

POLEMONIACEAE - Phlox Family

Eriastrum diffusum (A. Gray) H. Mason. Cool-season annuals; flowers pale blue. Dunes and sand flats. *Felger 98-55 & Evans*.

Eriastrum eremicum (Jeps.) H. Mason. Cool-season annuals; flowers dark blue. Sand flats. This is the southwestern record for this species, and the only plant in the Mohawk flora not in the Gran Desierto or near the Pinta Sands or Yuma Dunes. *Burgess 5059*; *Turner 95-32*.

Linanthus bigelovii (A. Gray) Greene [*Gilia bigelovii* A. Gray, 1870; *Gilia jonesii* A. Gray, 1886; *Linanthus bigelovii* var. *jonesii* (A. Gray) Brand; *L. jonesii* (A. Gray) Greene]. Cool-season annuals. Flowers white, nocturnal, opening at or near dusk and powerfully sweet-fragrant, sometime nauseously sweet, and closing before sunrise. Dunes including swales and sand flats. *Bowers 2993*; *Felger 98 54 & Evans*; *Reichenbacher 273*.

Linanthus jonesii is distinguished by glandular-stipitate calyces (sometimes quite densely so) and seeds constricted near the middle (appearing "pinched off"), whereas *L. bigelovii* sensu stricto is distinguished by glabrous

calyces and a bladdery, ellipsoid seed. However, in southwestern Arizona the variation seems continuous, the characters do not seem correlated with each other, there appears to be no discernable correlation with habitat or geography, and they do not seem to be distinct taxa.

Loeseliastrum schottii (Torr.) Timbrook [*Langloisia schottii* (Torr.) Greene]. Winter-spring annuals. Scattered, mostly in swales and sand flats, sometimes extending to higher dunes, seldom common. *Felger 98-53 & Evans; Goldberg 77-83; Turner 95-34.*

POLYGONACEAE Buckwheat Family

Chorizanthe brevicornu Torr. subsp. **brevicornu**. Brittle spineflower, short-horn spineflower. Cool-season annuals; flowers white and minute. Dunes, especially swales, dune slopes, and lower dunes; also on sand flats. *Felger 98-81 & Evans.*

Chorizanthe rigida (Torr.) Torr. & A. Gray. Rigid spineflower. Cool-season annuals; the dry skeletons persistent for several years; flowers white, minute and cryptic. Common and widespread on sand flats. *Felger 98-9 et al.; Felger 98-89 & Evans; Reichenbacher 271.*

Eriogonum trichopes Torr. var. **trichopes**. Little trumpet. Cool-season annuals, occasionally surviving the summer; flowers yellow. Dunes and sand flats. *Felger 98-57 & Evans; Salywon et al. 989* (ASU).

Nemacaulis denudata Nutt. var. **gracilis** Goodman & L.D. Benson. Woolly heads. Cool season annuals; Flowers minute, yellow, surrounded by yellow-green to white and pink woolly bracts. Mostly in dune swales, also lower to higher dunes. *Felger 98 13 & Evans; Salywon et al. 990* (ASU).

RESEDACEAE - Mignonette Family

Oligomeris linifolia (Vahl) J.F. Macbr. Desert cambess, slenderleaf cambess. Non-seasonal annuals; flowers inconspicuous, white and green. Playa, sand flats, and lower dunes. *Turner 95-20.*

SALICACEAE - Willow Family

Populus fremontii S. Watson subsp. **fremontii**. Cottonwood; *alamo*. Several saplings along the southern edge of the playa. Apparently they grew during the El Niño year of 1992-1993, and were still living by end of April 1994, having reached 2-2.5 m tall, but perished by the end of 1994. *Felger 96-153 & Turner; Phil Rosen,* 24 Apr 1994, photo.

SIMAROUBACEAE - Quassia Family

Castela emoryi (A. Gray) Moran & Felger [*Holacantha emoryi* A. Gray]. Crucifixion thorn; *corona de cristo*. Shrubs 2-3 m tall; May-July; flowers cream-yellow to pink; fruits densely clustered and persistent. Scattered on sand flats, and also lowermost dunes surrounding the playa. *Felger 96-162 & Turner; Reina-G. 96-216 & Van Devender.*

SOLANACEAE - Nightshade Family

Datura discolor Bernh. Poisonous nightshade, desert thorn-apple; *toloache*. Non-seasonal annuals, the plants frost-sensitive; flowers 8-17 cm long, corollas white with a purple flush in the throat, nocturnal and fragrant. Sand flats and probably on dunes. This is the largest-flowered plant in the region. *Felger & Turner*, 25 Sep 1996, observation.

Lycium parishii A. Gray var. **parishii**. Parish wolfberry; *salicieso*. Shrubs; reproductive at various seasons, especially late winter and early spring; corollas lavender. Washes in sand flats near north end of dunes. *Felger 98-20 et al.*

Physalis lobata Torr. [*Quincula lobata* (Torr.) Raf.]. Annual or perennial herbs with a deep tap root; flowers lavender, after sufficient rains at various seasons. Locally at the playa margins. *Felger 98-51 & Evans; Turner 95-29.*

TAMARICACEAE - Tamarisk Family

***Tamarix ramosissima** Ledeb. [*T. chinensis* of American authors, not Lour.?]. Saltcedar, tamarisk; *salado, pino salado*. One shrub at the southwest edge of the playa, first seen May 1995, and by June 1996 it had perished from drought. *Felger & Turner*, 25 Sep 1996, observation.

VISCACEAE - Mistletoe Family

Phoradendron californicum Nutt. Desert

mistletoe; *tóji*. Epiphytic perennial parasites; flowers small, green or yellow, at various seasons, especially January and February; highly fragrant and attracting honeybees and other insects; fruiting in same season. On widely scattered mesquite trees on sand flats. *Felger & Turner*, 24 Sep 1996, observation.

ZYGOPHYLLACEAE Caltrop Family

Kallstroemia californica (S. Watson) Vail. California caltrop; *mal de ojo*. Hot-weather annuals; flowers yellow to yellow-orange. Sand flats and dunes. *Felger 97-58 et al.; Felger 96 129 & Turner, 96-133, 96 160.*

Larrea divaricata Cav. subsp. **tridentata** (Sessé & Moç. ex DC.) Felger & C.H. Lowe [*L. tridentata* (Sessé & Moc. ex DC.) Cov.]. Creosotebush; *hediondilla, gobernadora*. Long-lived shrubs ca. 1–2 m tall with very hard wood; flowers yellow, various seasons. Dominant shrub or "canopy" across most of the sand flats and valley floor surrounding the dunes, and extending onto lower dunes and dune swales.

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BOOK NOTICES

D.M.J.S. Bowman. 2000. **Australian Rainforests: Islands of Green in a Land of Fire.** (ISBN 0-521-46568-0, hbk.). Cambridge University Press, The Edinburgh Bldg., Cambridge CB2 2RU, U.K. (Orders: 40 West 20th St., New York, NY 10011-4211, U.S.A. www.cup.org, www.cup.cam.ac.uk). $85.00, 345 pp., b/w photos, line drawings, graphs, 6" × 9".

Contents: **1)** Introduction; **2)** What is Australian rainforest?; **3)** The sclerophyll problem; **4)** The edaphic theory I. The control of rainforest by soil phosphorus; **5)** The edaphic theory II. Soil types, drainage, and fertility; **6)** The climate theory I. Water stress; **7)** The climate theory II. Light and temperature; **8)** The fire theory I. Field evidence; **9)** The fire theory II. Fire, nutrient cycling, and topography; **10)** The fire theory III. Fire frequency, succession, and ecological drift; **11)** The fire theory IV. Aboriginal landscape burning; **12)** The fire theory V. Aridity and the evolution of flammable forests; **13)** The fire theory VI. Fire management and rainforest conservation; **14)** Summary; followed by References and Index.

Ray L. Specht and Alison Specht. 2002. **Australian Plant Communities: Dynamics of Structure, Growth and Biodiversity.** (ISBN 0-19-551654-0, pbk.). Oxford University Press, Department REF, 198 Madison Avenue, New York, NY 10016, U.S.A. (Orders: 2001 Evans Road, Cary, NC 27513, U.S.A. 800-451-7556, fax 919-677-1303). $40.00, 492 pp., b/w photos, line drawings, graphs, 6" × 9".

Contents: **Part 1** Australian plant communities: Description: **1)** Energy/biomass system; **2)** Dynamics; **3)** Structural classification; **4)** Floristic classification; **5)** Australian plant communities during the Late Cretaceous; **6)** Australian plant communities during the Cainozoic; **7)** Australian plant communities today; **8)** Aboriginal impact; **Part 2** Australian plant communities: Community physiology; **9)** Energetics; **10)** Temperature; **11)** Evaporative aerodynamics; **12)** Available water; **13)** Ecophysiological leaf attributes; **14)** Waterlogging; **15)** Nutrient deficiencies; **16)** Nutrient toxicities; **17)** Biodiversity and energetics; **18)** Monitoring; 19) Scientific management; References; Systematic Index; and General Index.

The authors believe this book will be an invaluable reference for practicing environmental scientists, planners, and managers. It will also be an excellent text for undergraduate and graduate course in environmental science, resource management, and environmental planning and impact assessment.

A FLORISTIC SURVEY OF BIG BRANCH MARSH NATIONAL WILDLIFE REFUGE, ST. TAMMANY PARISH, LOUISIANA

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ABSTRACT

Big Branch Marsh National Wildlife Refuge is a U.S. Department of the Interior Fish and Wildlife Service complex comprising approximately 5,870 ha (14,500 acres). A floristic survey was conducted to provide refuge staff with a checklist of vascular plant species, along with species abundance and habitat preference when one existed. Collecting trips made to the refuge from August 1999 through April 2002 yielded 563 infraspecific taxa of vascular plants representing 117 families and 309 gen era. The four largest families are Poaceae, Cyperaceae, Asteraceae, and Fabaceae. Descriptions of salient plant communities are provided.

RESUMEN

El Refugio Nacional de Vida Salvaje de Big Branch Marsh es un complejo del Servicio del Departamento de Pesca Interior y Vida Salvaje de los Estados Unidos que tiene aproximadamente 5,870 ha (14,500 acres). Se realizó un estudio florístico para ofrecer al personal del Refugio un listado de las especies de plantas vasculares, junto con abundancia de especies y preferencia de hábitat cuando existía. Los viajes de recolección al refugio de agosto de 1999 a abril de 2002 dieron 563 taxa infraespecíficos de plantas vasculares pertenecientes a 117 familias y 309 géneros. Las cuatro familias más grandes son Poaceae, Cyperaceae, Asteraceae, y Fabaceae. Se ofrecen descripciones de las comunidades vegetales más importantes.

INTRODUCTION

The National Wildlife Refuge System is administered by the U.S. Department of the Interior, Fish and Wildlife Service. The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. Big Branch Marsh National Wildlife Refuge (BBMNWR), which was established in 1994, is one of over 530 refuges throughout the country and one of 22 refuges in Louisiana. At the onset of this survey, BBMNWR was the last large undeveloped area on the rapidly develop-

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ing north shore of Lake Pontchartrain. The management objectives of BBMNWR are to provide (1) habitat for a natural diversity of wildlife associated with Big Branch Marsh, (2) wintering habitat for migratory waterfowl, (3) nesting habitat for wood ducks, (4) habitat for non-game migratory birds, and (5) opportunities for public outdoor recreation.

The forested areas of BBMNWR are primarily managed for the federally listed endangered red-cockaded woodpecker (*Picoides borealis*). About 12 clusters of these birds are currently active on the refuge. Red-cockaded woodpeckers build their nests in live pine trees and require an open understory necessitating prescribed burns by refuge personnel every 3—4 years. Refuge marshes are also burned every 2—3 years to improve habitat for wading birds and migratory waterfowl. The understanding and management of any animal community demands (1) defining the plant communities in which they live, (2) defining the surrounding plant communities in which they move in and out of, and (3) identifying the plant species utilized for food, cover, and nesting. As is the case with most National Wildlife Refuges, no detailed floristic study had been conducted on BBMNWR. Therefore, a floristic survey was conducted to provide refuge staff with a checklist of vascular plant species and information on species abundance and habitat preference.

Study Area

BBMNWR is located between 30° 15' 35" and 30° 19' 54"N latitude and 89° 54' 37" and 90° 00' 53"W longitude in St. Tammany Parish, Louisiana (Fig. 1). The refuge lies within the Coastal Plain Province of the Atlantic Plain Division (Fenneman 1928). The refuge headquarters and visitor center are located W of Hwy. 434 at about 30° 19' 17"N, 89° 56' 14"W in the town of Lacombe. Several minor tributaries border and traverse the refuge holdings. The refuge is bounded to the W by Cane Bayou, bisected by Bayou Lacombe and its tributaries, and traversed by Bayou Liberty, Bayou Bonfouca, Cypress Bayou, Bayou due Chien, their tributaries, and other small unnamed tributaries. The most notable refuge boundary is Lake Pontchartrain, a shallow, flat-bottomed fresh to brackish water body with an average depth of approximately 3-m (Steinmayer 1939). The refuge lies entirely within its floodplain between the 0 and 5 foot contour lines. Lake salinity normally ranges from 1 to 10 $^{0}/_{00}$. In recent drought years, however, salinity has reached 20 $^{0}/_{00}$ (pers. obs.). The climate in St. Tammany Parish is temperate with an average winter temperature of 12° C, and a daily minimum average of 5° C. Average summer temperature is 27° C, and the average daily high is 33° C (Trahan et al. 1990). Total annual precipitation is 155 cm, average relative humidity during the day is 60% and is 90% at dawn (Trahan et al. 1990).

The approximately 5870 ha (14,500 acre) refuge is described by refuge staff as predominately a mixture of intermediate and fresh marsh, pine flatwoods,

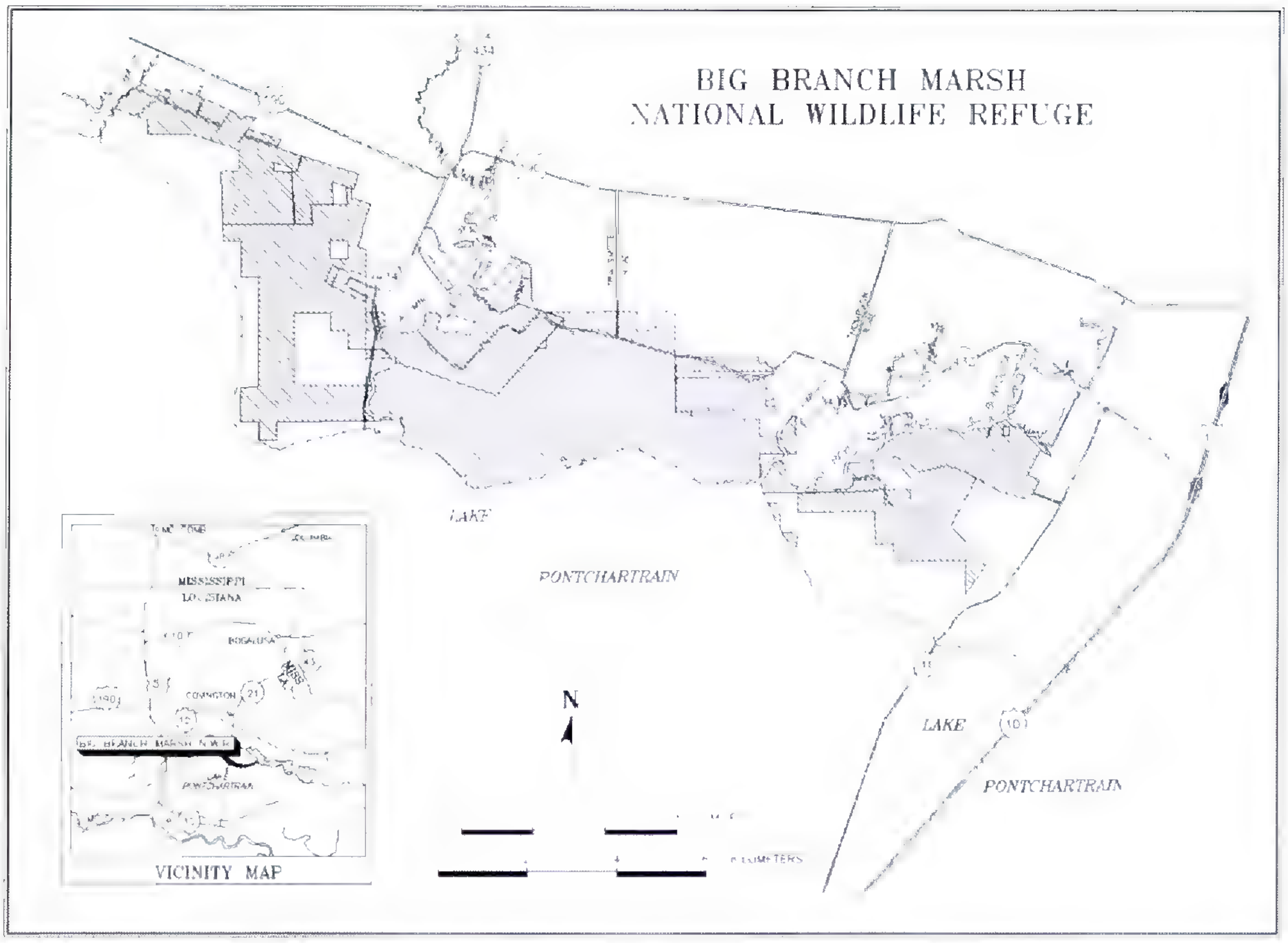


FIG. 1. Map showing location and boundaries of Big Branch Marsh NWR during survey.

pine islands, pine ridges, and hardwood hammocks. The forests in the area were almost completely clear cut early in the 20th century (Ellis 1981). Most of the evergreen forests in the region were dominated by longleaf pine (*Pinus palustris* Mill.) prior to modern silviculture operations and fire suppression. Currently, either slash pine (*P. elliottii* Engelm. var. *elliottii*), loblolly pine (*P. taeda* L.), or longleaf pine are dominant or co-dominant in refuge evergreen forests.

The most notable physiognomic feature of the refuge is a distinct line of demarcation where marsh meets pine flatwoods. The prairie terrace is comprised of consolidated sediments formed during the Pleistocene resulting from rising and falling sea levels and changes in the course of the Mississippi River (Fisk & McFarlan 1955; Saucier 1963). The forested areas of the refuge overlay the terrace. The entire refuge area is subsiding, but the effect is most noticeable in the existing marshes. In some locations, the marsh-forest edge is lined with dead stands of pine trees that have been inundated with brackish lake water.

METHODS

Topographical maps and color infrared aerial photos were examined and interpreted to locate different habitats and plan fieldwork. Collecting trips were made to the refuge from August 1999 through April 2002. The objectives of each trip

were the collection of voucher specimens, careful notation of apparent habitat preference, and estimates of abundance of each species. Voucher specimens are housed at the Tulane University Herbarium (NO). Duplicate specimens, when available, were provided to the staff of BBMNWR. Identifications were made using regional manuals including Allen (1992), Correll and Johnston (1970), Cronquist (1980), Gandhi and Thomas (1989), Godfrey (1988), Godfrey and Wooten (1979, 1981), Gould (1975), Isely (1990), and Radford et al. (1968).

RESULTS

Floristics

Collecting trips yielded 563 infraspecific taxa of vascular plants representing 117 families and 309 genera (Table 1). The four families containing the most infraspecific taxa (in parenthesis) are Poaceae (94 spp.), Cyperaceae (64 spp.), Asteraceae (61 spp.), and Fabaceae (25 spp.). One species, *Imperata brasiliensis* (L.) Beauv., is listed by the U.S. Department of Agriculture as a noxious weed. Non native species accounted for 12.8 % of the total species. No Federally-listed threatened or endangered plant species were found.

Plant Communities

The distribution and composition of plant communities on the refuge appear most influenced by the salinity and tidal activity of Lake Pontchartrain and larger tributaries. Other major influences are topography, geology, soil type, weather, historic and ongoing disturbances, and management regimes. Plant communities were described to indicate diversity and uniqueness and to aid in future management practices. The following plant communities were defined by comparing field observations of dominant woody and herbaceous species and hydrological regimes to The Nature Conservancy's *International Classification of Ecological Communities: Terrestrial Vegetation of the Southeastern United States* (ICEC) (Weakly et al. 1998). Plant community names of the ICEC hierarchy are used. Following the ICEC alliance plant community name, the name used by refuge staff is listed in parenthesis. Communities at the alliance and association levels are reported. These are the two lowest communities in the hierarchy of classification listed in the ICEC and are based on floristics. Associations within alliances are discussed under the alliances. Conservation ranks of G3 or lower are reported (G1–critically imperiled globally; G2–imperiled globally; G3–rare or uncommon globally). A myriad of disturbed sites such as borrow pits, ditches, roads, spoil areas, logging ruts, and mowed rights-of-way may occur in each alliance or association, typically supporting a variety of ruderal, wetland, and aquatic species.

Forest Alliances

***Fagus grandifolia–Magnolia grandiflora* Forest Alliance (Beech-Magnolia Woods).** A single representative association of this alliance was found on BBMNWR,

TABLE 1. Statistical taxonomic summary of the vascular flora of Big Branch Marsh NWR.

				Infraspecific Taxa	
Class	**Families**	**Genera**	**Native**	**Introduced**	**Total**
Lycopodiopsida	1	1	1	_	1
Isoëtopsida	1	1	1	_	1
Polypodiopsida	9	9	8	2	10
Pinopsida	2	2	6	_	6
Liliopsida	24	85	194	21	215
Magnoliopsida	80	211	281	49	330
Totals	117	309	491	72	563

the *Fagus grandifolia* Ehrh. (American beech)–*Magnolia grandiflora* L. (southern magnolia)–*Quercus nigra* L. (water oak)–*Pinus glabra* Walt. (spruce pine)/*Viburnum dentatum* L. (southern arrow-wood) Association. This association occurs on uplands fringed by the marshes adjacent to Cane Bayou. Common trees in the subcanopy include *Carpinus caroliniana* Walt. (coastal ironwood), *Carya glabra* (Mill.) Sweet. (pignut hickory), and *Quercus falcata* Michx. var. *falcata* (southern red oak). Common shrubs are *Aesculus pavia* L. (red buckeye), *Callicarpa americana* L. (beauty berry), *Erythrina herbacea* L. (coralbean), *Halesia diptera* Ellis. (two-wing silverbell), *Symplocos tinctoria* (L.) L'Her. (sweetleaf), and *Vaccinium arboreum* Marsh. (farkleberry). Southern arrow-wood is apparently absent in this association at BBMNWR. Common herbaceous species include *Chasmanthium laxum* (L.) Yates var. *laxum* (slender spikegrass), *Carex* spp. (caric-sedges), and *Panicum* spp. (panic-grasses). This association is easily viewed at the Cane Bayou access area.

***Nyssa aquatica*–(*Taxodium distichum*) Semipermanently Flooded Forest Alliance (Floodplain Swamps).** A single representative association of this alliance was found on BBMNWR, the *Nyssa aquatica* L. (swamp tupelo)–*Nyssa biflora* Walt. (swamp blackgum) Forest Association. This association occurs along a small, meandering, unnamed tributary SE of Bremermann Road near the W boundary of the refuge (Fig. 2A). Common trees in the subcanopy include *Acer rubrum* L. var. *drummondii* (Hook. & Arn. ex Nutt.) Sarg. (swamp red maple) and *Fraxinus caroliniana* Mill. (water ash). Common shrubs are *Cephalanthus occidentalis* L. (buttonbush), *Cornus foemina* Mill. (gray dogwood), *Itea virginica* L. (Virginia-willow), and *Planera aquatica* (Walt.) J.F. Gmel. (planertree). Common herbaceous species occurring in soils saturated for long duration include *Echinodorus cordifolius* (L.) Griseb. (heart-leaf burhead), *Iris virginica* L. (southern blue flag), *Panicum gymnocarpon* Ell. (swamp panicgrass), *Polygonum densiflorum* Meisn. (denseflower knotweed), and *Saururus cernuus* L. (lizard's tail). Woody and herbaceous species occuring on small hum-

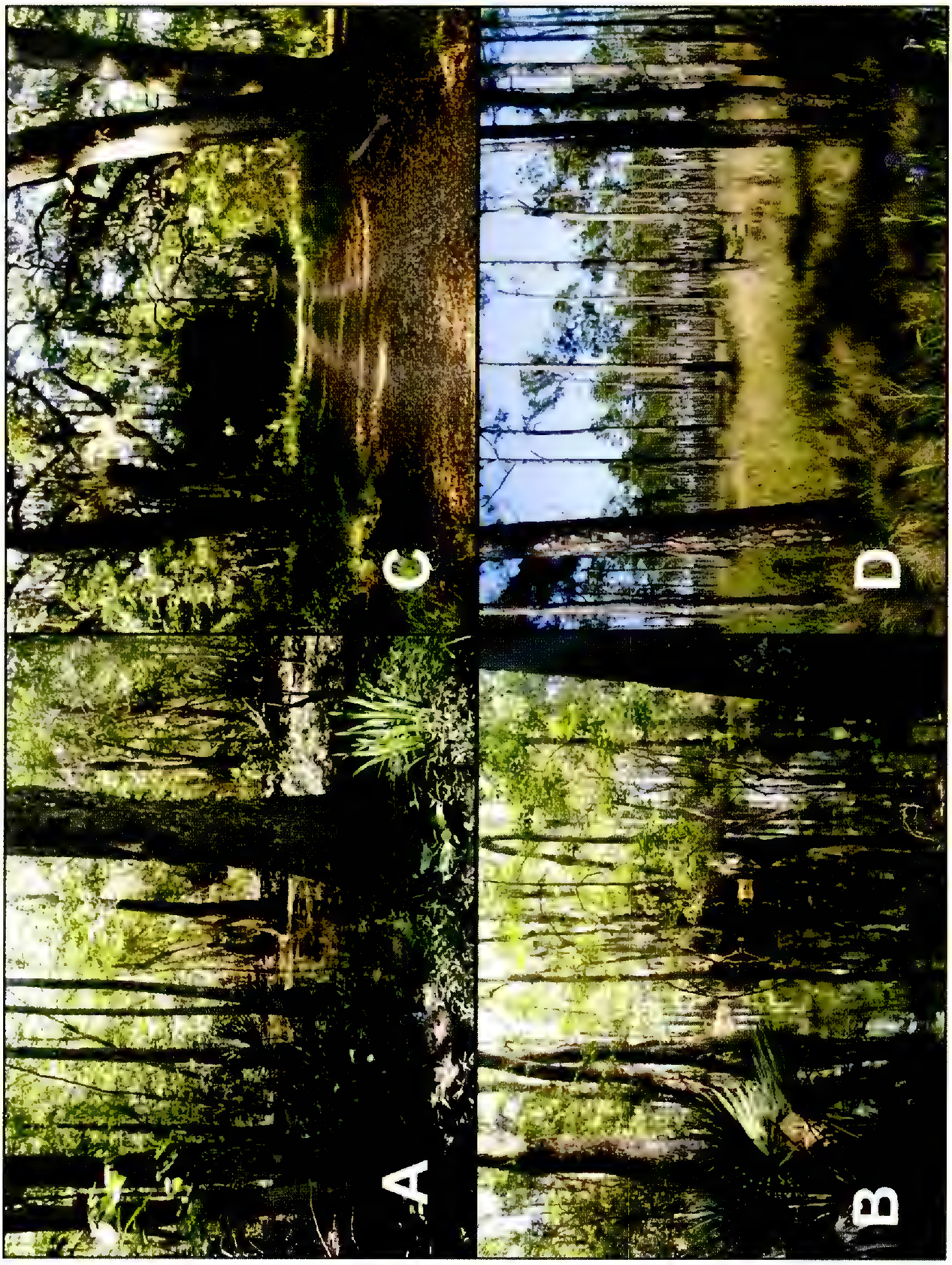


Fig. 2. Plant communities of Big Branch Marsh NWR. **A.** Floodplain swamp along unnamed tributary; trees are *Nyssa aquatica* and *N. biflora*. **B.** *Nyssa biflora* swamp along Boy Scout Road also dominated by *Sabal minor*, *Crataegus opaca*, and *Sapium sebeferum*. **C.** Example of hardwood hammock along Boy Scout Road; trees are *Quercus virginiana*. **D.** Pine flatwoods showing overstory of *Pinus elliottii* var. *elliottii* and lush undergrowth of *Spartina patens* and *Panicum virgatum*.

mocks, tree bases, and other higher places within this forest association include *Carex debilis* Michx. var. *debilis*. (weak caric-sedge), *C. lonchocarpa* Willd. (spear-fruit caric-sedge), *C. louisianica* L.H. Bailey. (Louisiana caric-sedge), *C. reniformis* (L.H. Bailey) Small (kidney-fruit caric-sedge), *C. tribuloides* Wahl. var. *sangamonensis* Clokey. (sangamon blunt broom caric-sedge), *Hypoxis curtissii* Rose (Curtiss' yellow stargrass), *Ilex verticillata* (L.) Gray (winterberry), and *Rhododendron viscosum* (L.) Torr. (swamp azalea).

***Nyssa biflora* Pond Seasonally Flooded Forest Alliance (Gum Swamps).** A single unnamed forest association was found within the swamp blackgum Pond Seasonally Flooded Forest Alliance. This unnamed association would be called a swamp blackgum/*Crataegus opaca* Hook. & Arn. (mayhaw) Pond Seasonally Flooded Forest Association. The canopy of this association is dominated by swamp blackgum with the mid-story dominated by mayhaw, and is rare at BBMNWR. This association is a ponded wetland within an upland forest and should have a conservation rank of G3. Another woody species present is *Sapium sebiferum* (L.) Roxb. (Chinese tallow-tree). *Lemna minor* L. (lesser duckweed) commonly forms a dense mat on the water's surface. Characteristic herbaceous species on pond margins can include *Carex gigantea* Rudge. (giant caric-sedge), *C. glaucescens* Ell. (southern waxy sedge), *C. joorii* L. H. Bailey (cypress swamp sedge), southern blue flag, *Sabal minor* (Jacq.) Pers. (dwarf palmetto), *Spiranthes odorata* (Nutt.) Lindl. (fragrant ladies'-tresses), and *Woodwardia areolata* (L.) Moore. (netted chainfern). During times of drought or low water, exposed soils are quickly colonized with species such as *Eragrostis hypnoides* (Lam.) B.S.P. (creeping lovegrass), *Heliotropium indicum* L. (Indian heliotrope), and *Lindernia dubia* (L.) Penn. (false pimpernel). An example of this alliance can be viewed S of Boy Scout Road, near its terminus at Bayou Lacombe (Fig. 2B).

***Pinus taeda* Planted Forest Alliance (Pine Savanna)**. A *Pinus taeda* L. (loblolly pine) Planted Forest Association borders the refuge boundaries N of Bayou Paquet Road, just E of its intersection with Transmitter Road. Clearcut portions of this association have developed into herbaceous bogs that overlap into clearings and fire-brakes on refuge boundaries.

***Pinus taeda* Forest Alliance (Mixed Woods)**. This alliance serves as a placeholder for refuge successional forests dominated by loblolly pine. We did not assign an association name due to the great floristic variation in this alliance. However, quanitative analysis would surely yield numerous associations. Other canopy dominates include *Liquidambar styraciflua* L. (sweetgum), *Nyssa sylvatica* Marsh. (blackgum), *Quercus similis* Ashe. (swamp post oak), *Q. falcata* Michx. var. *pagodifolia* Ell. (cherrybark oak), and southern red oak. Shrub and herbaceous strata are well developed and species composition varies with microtopography and hydrologic regime. See the annotated checklist for other species found in this alliance.

***Quercus laurifolia*–*Nyssa biflora* Saturated Forest Alliance (Forest Swales).** This alliance best describes associations encountered in forest swales and drainages within mixed woods. The swamp blackgum–*Quercus laurifolia* (diamondleaf oak)–*Quercus phellos* (willow oak) / dwarf palmetto Forest Association (G3) is common in the refuge. Other common woody species include swamp red maple, mayhaw, and water oak. Herbaceous vegetation is often sparse or absent under dense canopies. However, in clearings and forest openings herbaceous species include Louisiana caric-sedge, southern blue flag, *Leersia lenticularis* Michx. (catchfly grass), *Rhynchospora corniculata* (Lam.) Gray. (shortbristle horned beaksedge), lizard's tail, and netted chainfern.

***Quercus* (*michauxii*, *falcata* var. *pagodifolia*, *shumardii*)–*Liquidambar styraciflua* Temporarily Flooded Forest Alliance (Oak-Hickory Ridge).** This alliance best describes unnamed associations that occupy the forested portions of BBMNWR dominated by *Quercus michauxii* Nutt. (swamp chestnut oak) and sweetgum. *Quercus shumardii* Buckl. (shumard oak) is absent on BBMNWR. A community dominated by swamp chestnut oak, sweetgum, pignut hickory, and swamp post oak exists on a broad ridge that spans NW of a small day-use parking area at the intersection of Bertha Lane and Lucille Road. This association also occurs as a transition or fringe allied with other forest associations.

***Quercus virginiana* Temporarily Flooded Forest Alliance (Hardwood Hammocks).** A single association was placed under this alliance, a *Quercus virginiana* Mill. (live oak) / (dwarf palmetto, *Serenoa repens* (Bartram) J. K. Small [saw palmetto]) Forest Association. At the terminus of Boy Scout Road, a live oak forest occurs on old archeological features, and grades into low lying areas that are temporarily flooded during storm events (Fig. 2C). The shrub stratum is poorly developed with a few scattered dwarf palmetto. Herbaceous cover is sparse with slender spikegrass, and *Elephantopus* spp. (elephant's-foot). Saw palmetto is absent at BBMNWR.

Woodland Alliances

***Pinus elliottii* Saturated Temperate Woodland Alliance (Pine Flatwoods).** This alliance is represented by the *Pinus elliottii* Engelm. var. *elliottii* (slash pine)/ *Spartina patens* (Ait.) Muhl. (saltmeadow cordgrass)–*Juncus roemerianus* Scheele. (black needlerush)–(*Panicum virgatum* L. [switchgrass]) Woodland Association (G3). These flat, low-lying wetlands adjacent to the refuge marshes have an open to sometimes dense canopy of slash pine. Subcanopy and shrub layers are usually absent, though species such as *Morella cerifera* (L.) Small (wax myrtle), *Iva frutescens* L. (maritime marsh-elder), dwarf palmetto, *Baccharis halimifolia* L. (groundsel-tree), *B. angustifolia* Michx. (saltwater false-willow), and Chinese tallow tree may be present, particularly in areas not subjected to fire. The herbaceous stratum is dense and is dominated by saltmeadow

cordgrass, switchgrass, *Solidago sempervirens* L. (seaside goldenrod), and *Euthamia leptocephala* (Torr. & Gray) Greene. (bushy fragrant-goldenrod). Other conspicuous though less common herbs include *Symphyotrichum* spp., *Eryngium yuccifolium* Michx. (rattlesnake master), *Oxypolis filiformis* (Walt.) Britt. (leafless cowbane), and *Asclepias lanceolata* Walt. (lance-leaf milkweed). This association is not inundated by normal daily tides, but receives inundation during storm events. Water tables are high due to landscape position and soil texture. Within this association are a few scattered stands of *Cladium mariscus* (L.) Pohl subsp. *jamaicense* (Crantz) Kükenth. (sawgrass). The best place to observe this association is along Boy Scout Road (Fig. 2D).

***Pinus palustris–Pinus* (*echinata*, *taeda*) Woodland Alliance (Longleaf Pine Savanna).** A *Pinus palustris* Mill. (longleaf pine)–*Pinus* (*echinata* [shortleaf pine], loblolly pine) / *Schizachyrium scoparium* (Michx.) Nash. (little bluestem) Woodland Association represents this alliance at BBMNWR. Subcanopy species include saplings of the nominal species and swamp post oak. Dominant shrubs are *Ilex vomitoria* Ait. (yaupon) and wax myrtle. Herbaceous cover is dense and is dominated by little bluestem, *Andropogon* spp., and *Aristida longespica* Poir. var. *geniculata* (Raf.) Fern. (plains threeawn). This forest occurs on mesic flats near Lake Pontchartrain that are periodically inundated by storm events. This community is somewhat inaccessible and located several miles from paved roads in the Salmen Tract in the city of Slidell. Near the end of the study, a prescribed burn management regime was initiated in this woodland alliance. This will undoubtedly alter the community composition.

Herbaceous Alliances

***Nymphaea odorata* Permanently Flooded Temperate Herbaceous Alliance (Sloughs).** This alliance is represented by a single association, the *Nymphea odorata* Ait. var. *odorata* (white water lily) Herbaceous Vegetation Association. This association occurs as semipermanently flooded sloughs, ditches, borrow ponds, and marsh ponds, usually within other communities. The best place to observe this association is from an interpretive station along Boy Scout Road near the parking area (Fig. 3A).

***Sagittaria lancifolia* Semipermanently Flooded Herbaceous Alliance (Fresh Marsh).** Two associations represent this alliance. The first is a *Sagittaria lancifolia* L. (lanceleaf arrowhead) Herbaceous Vegetation Association (G3). This shallow freshwater marsh is dominated by a monoculture of lanceleaf arrowhead and is best observed along Boy Scout Road (Fig. 3B). The second is an unnamed association that forms dense marsh fringes along Cane Bayou (Fig. 3C). This association, based on field observations, would be called a lanceleaf arrowhead–*Schoenoplectus tabernaemontani* (K.C. Gmel.) Palla (softstem bullrush)–*Schoenoplectus americanus* (Pers.) Volk. (olney threesquare) Herba-

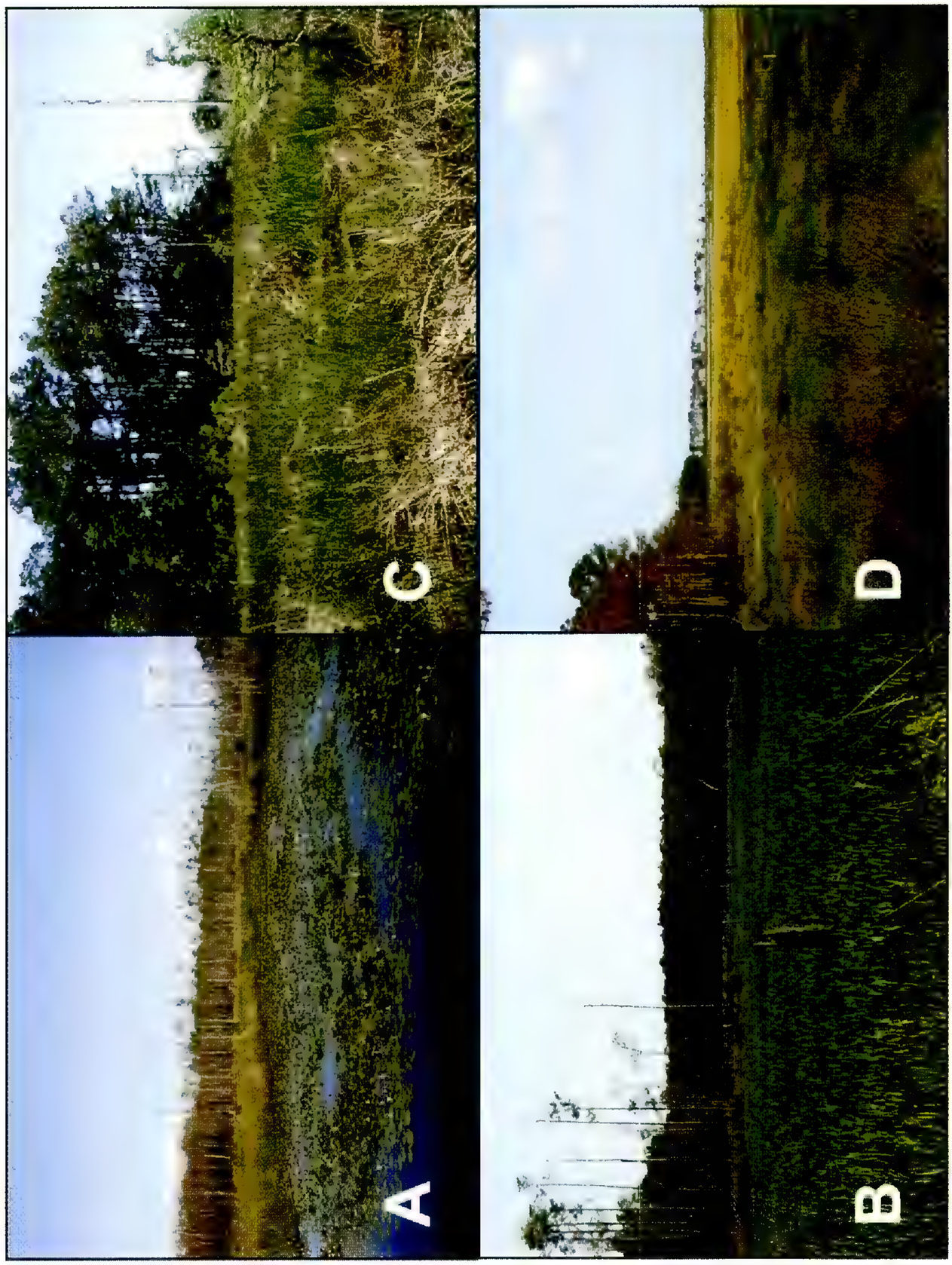


Fig. 3. Plant communities of Big Branch Marsh NWR. **A.** Slough along Boy Scout Road with *Nymphea odorata* var. *odorata* rimmed with dead pines that have succumbed to subsidence. **B.** Fresh marsh along Boy Scout Road dominated by *Sagittaria lancifolia* and adjacent pine flatwoods. **C.** Fresh marsh of *Schoenoplectus tabernaemontani*, *S. americanus*, and *Eleocharis palustris* adjacent to Bayou Cane. **D.** Sharp transition from intermediate marsh community to flatwoods.

ceous Vegetation Association with a proposed conservation rank of G3. Other common herbaceous species include *Eleocharis palustris* (L.) R. & S. (great plains spikerush), *Ptilimnium capillaceum* (Michx.) Raf. (thread-leaf mock bishop's-weed), and *Alternanthera philoxeroides* (Mart.) Griseb. (alligator weed). A few widely scattered *Taxodium ascendens* Brongn. (pond cypress) are present in this association.

***Spartina alterniflora* Tidal Herbaceous Alliance (Smooth Cordgrass Marsh).** The *Spartina alterniflora* Lois. (saltmarsh cordgrass) Louisianian Zone Herbaceous Vegetation Association occurs as monotypic bands of saltmarsh cordgrass along tidal streams, canals, and littoral zones on the shore of Lake Pontchartrain.

***Spartina patens*–(*Distichlis spicata*) Tidal Herbaceous Alliance (Intermediate Marsh).** The saltmeadow cordgrass–*Schoenoplectus* (olney threesquare, *pungens* [Vahl] Palla [common threesquare])–(*Distichlis spicata* (L.) Greene [saltgrass]) Herbaceous Vegetation Association (G3) inhabits the refuge marshes inundated by spring tides. *Bolboschoenus robustus* (Pursh) Soják (Alkali Bulrush) replaces olney threesquare and common threesquare as found elsewhere in marshy sites at BBMNWR. Other common herbaceous species include switch grass, *Eleocharis cellulosa* Torr. (Gulf Coast spikerush) and black needlerush. A band of shrubs including groundsel-tree and maritime marsh-elder can occur as a transition zone between this association and dryer communities or in small scattered thickets. The best place to observe this community is from the observation platform on Boy Scout Road (Fig. 3D).

***Vallisneria americana* Permanently Flooded–Tidal Herbaceous Alliance (Grass Beds).** A *Vallisneria americana* Michx. (American eelgrass) Estuarine Bayou Herbaceous Vegetation Association (G3) occurs along the shores of Bayou Bonfuca, several tidal canals, sloughs, and marsh ponds. Other aquatic plants common in this association include *Myriophyllum sibiricum* Kom. (siberian water-milfoil), *Ruppia maritima* L. (wigeongrass), and *Zannichellia palustris* L. (horned pondweed).

EXOTIC SPECIES OF CONCERN

The following non-native species are, or have the potential to become, serious and difficult to control weeds and may threaten the diversity of plant communities of BBMNWR. **Woody Species:** Chinese tallow-tree, a native of China and Japan, and a tenacious weed of the SE United States, was encountered in most of the refuge forests and woodlands. This species is not well established in these habitats, but should be monitored closely. *Ligustrum sinense* Lour. (common privet), a native of Europe, is well established and frequent in mixed woods and oak hickory forests. *Poncirus trifoliata* (L.) Raf. (trifoliate orange) is native to Asia. This species has escaped from cultivation near an old homesite at the ter-

minus of Boyscout Road and has become well established in hardwood hammocks. Armed with stout spines, this shrub forms inpenetrable thickets. Another native to Asia, *Rosa bracteata* J. Wendl. (Macartney rose), is occasional in mixed woods. **Woody and Herbaceous Vines:** *Lonicera japonica* Thunb. (Japanese honeysuckle) is a climbing vine that was occasionally encountered in oak hickory forests. A more troublesome herbaceous vine was *Lygodium japonicum* (Thunb.) Sw. (Japanese climbing fern), a native of Asia and the Austral Tropics. This vine was well established in mixed and beech magnolia woods. **Herbaceous Species:** *Alternanthera philoxeroides* (Mart.) Griseb. (alligator weed), native to Australia, was frequent in fresh marsh and ditches. *Colocasia esculenta* (L.) Schott (wild taro), a native to Asia, was restricted to roadside ditches SE of Bremermann Road near the W boundary of the refuge. *Imperata brasiliensis* (L.) Beauv. (Imperata) is Native to Tropical America and becoming well established along Boyscout Road and other nearby locations. Other grasses occasional to frequently abundant in disturbed areas with the potential to become a problem include *Paspalum dilatatum* Poir. (dallis-grass) and *Paspalum urvillei* Steud. (Vasey-grass), both native to South America, *Paspalum notatum* Flüggé. (bahia-grass) native to Latin America, and *Sorghum halepense* (L.) Pers. (Johnson-grass), native to the Mediterranean.

ANNOTATED CHECKLIST OF SPECIES

Plant names are arranged by class, and then listed alphabetically within class by family, genus, species, and infraspecific rank using the classification systems found in Cronquist (1981), Kartesz (1994), Jones et al. (1997), or more recent classifications found in monographs. Applicable synonymy for select species is provided when considered useful. Each taxon is followed by a brief description of its habitat type(s). Next is a subjective estimate of relative abundance using the following scheme: very rare–known from only a single locale with few individuals; rare–known from more than one locale, generally with small populations or one locale with numerous individuals; infrequent–not always in the stated community type(s), usually in small numbers; occasional–often in the community type(s), but rarely in large numbers; frequent–usually encountered in the community type(s), but not always in large numbers; and abundant–expected in the type, usually in large numbers. Collectors and collection numbers are David J. Rosen (DJR), James M. Joyner (JMJ), and Gary M. Couret (GMC). Non-native taxa are based on Thomas and Allen (1993, 1996, 1998) and indicated by an asterisk (*).

LYCOPODIOPSIDA

LYCOPODIACEAE

Lycopodiella alopecuroides (L.) R.Cranfill [*Lycopodium alopecuroides* L.], bogs, frequent, *DJR 1654.*

ISOËTOPSIDA

SELAGINELLACEAE

Selaginella apoda (L.) Spring, oak hickory ridge, occasional, *DJR 969.*

POLYPODIOPSIDA

ASPLENIACEAE

Asplenium platyneuron (L.) Oakes.ex D.C. Eat., oak hickory ridge, occasional, *JMJ 1308.*

BLECHNACEAE

Woodwardia areolata (L.) Moore, forest swales, occasional, *DJR 1384.*

Woodwardia virginica (L.) Sm., mixed woods, occasional, *DJR 1059.*

DENNSTAEDTIACEAE

Pteridium aquilinum (L.) Kuhn, oak hickory ridge, occasional, *DJR 1397.*

DRYOPTERIDACEAE

Onoclea sensibilis L., forest swales, infrequent, *DJR 1388.*

OSMUNDACEAE

Osmunda regalis L, forest swales, occasional, *DJR 1066.*

PARKERIACEAE

**Ceratopteris thalichtroides* (L.) Brongn., gum swamps, very rare, *DJR 1746.*

POLYPODIACEAE

Pleopeltis polypodioides (L.) Andrews & Windham var. *michauxiana* (Weath.) Andrews & Windham, epiphyte on live oaks, frequent, *JMJ 1343.*

LYGODIACEAE

**Lygodium japonicum* (Thunb.) Sw., mixed woods, beech magnolia woods, occasional, *JMJ 1328.*

THELYPTERIDACEAE

Thelypteris kunthii (Desv.) Morton., roadsides, mixed woods, frequent, *DJR 1060.*

PINOPSIDA

PINACEAE

Pinus elliottii Engelm. var. *elliottii*, pine flatwoods, mixed woods, abundant, *DJR 1953.*

Pinus taeda L., pine flatwoods, mixed woods, longleaf pine savanna, abundant, *DJR 984.*

Pinus glabra Walt, beech magnolia woods, ridges, occasional, *DJR 1221.*

Pinus palustris Mill., longleaf pine savanna, frequent, *DJR 1682.*

TAXODIACEAE

Taxodium ascendens Brongn., fresh marsh, infrequent, *JMJ 1303.*

Taxodium distichum L., bayou edge, fresh marsh, occasional, *JMJ 1291.*

LILIOPSIDA

ALISMATACEAE

Echinodorus cordifolius (L.) Griseb., floodplain swamps, frequent, *DJR 1740.*

Sagittaria graminea Michx., borrow ditches, forest swales, frequent, *JMJ 1315.*

Sagittaria lancifolia L., fresh marsh, borrow ditches, abundant, *DJR 1356.*

ALLIACEAE

Allium canadense L., disturbed places, frequent, *DJR 1038.*

AMARYLLIDACEAE

Crinum americanum L., canal W of Lake Road, occasional, *DJR 1241.*

Hymenocallis lirosome (Raf.) Shinners, forest swales, occasional, *DJR 999.*

ARACEAE

Arisaema triphylla (L.) Schott. subsp. *quinatum* (Nutt.) Hutt., oak hickory ridge, infrequent, *JMJ 1273.*

**Colocasia esculenta* (L.) Schott, borrow ditches, rare, *DJR 1225.*

Peltandra virginica (L.) Schott, bayou edge, infrequent, *DJR 1051.*

ARECACEAE

Sabal minor (Jacq.) Pers., mixed woods, forest swales, gum swamps, frequent, *JMJ 1314.*

BROMELIACEAE

Tillandsia usneoides L., mixed woods, frequent, *JMJ 1290.*

COMMELINACEAE

Commelina diffusa Burm., forest swales, frequent, *DJR 1020.*

Commelina virginica L., forest swales, occasiona , *DJR 1265.*

Tradescantia hirsutiflora Bush, roadsides, mixed woods, occasional, *DJR 1392.*

Tradescantia virginiana L., oak hickory ridge, occasional, *JMJ 1272.*

CYPERACEAE

Bolboschoenus robustus (Pursh) Soják [*Scirpus robustus* Pursh], intermediate marsh, frequent, *DJR 1230.*

Carex abscondita Mack., beech magnolia woods, occasional, *DJR 1366.*

Carex albicans Willd. ex Spreng. var. *australis* (Bailey) J. Rettig, oak hickory ridge, frequent, *DJR 968.*

Carex albolutescens Schwein., beech magnolia woods, infrequent, *DJR 1374.*

Carex complanata Torr. & Hook., oak hickory ridge, mixed woods, frequent, *DJR 1027.*

Carex crebriflora Wieg., floodplain swamps, infrequent, *DJR 1990.*

Carex debilis Michx. var. *debilis*, floodplain swamps, infrequent, *DJR 1437.*

Carex digitalis Schkuhr ex Willd. var. *floridana* (Bailey) R. Naczi & C. Bryson, beech magnolia woods, occasional, *DJR 1370.*

Carex flaccosperma Dew., oak hickory ridge, frequent, *DJR 1025.*

Carex frankii Kunth, forest swales, infrequent, *DJR 1110.*

Carex gigantea Rudge, gum swamps, rare, *DJR 1103.*

Carex glaucescens Ell., pine flatwoods, occasional, *DJR 950.*

Carex joorii L. H. Bailey, gum swamps, occasional, *DJR 1744.*

Carex lonchocarpa Willd., floodplain swamps, in frequent, *DJR 1436.*

Carex longii Mack., oak hickory ridge, mixed woods, frequent, *DJR 1028.*

Carex louisianica L. H. Bailey, forest swales, flood plain swamps, infrequent, *DJR 1432.*

Carx lurida Wahl., borrow ditcnes, infrequent *DJR 2003.*

Carex nigromarginata Schwein. var. *floridana* (Schwein.) Kükenth, beech magnolia woods, occasional, *DJR 1974.*

Carex reniformis (L. H. Bailey) Small, floodplain swamps, occasional, *DJR 1435.*

Carex striatula Michx., beech magnolia woods, occasional, *DJR 1369.*

Carex texensis (Torr.) L.H. Bailey, disturbed places, infrequent, *DJR 1041.*

Carex triangularis Bock., beech magnolia woods, occasional, *DJR 1365.*

Carex tribuloides Wahl. var. *sangamonensis* Clokey, beech magnolia woods, floodplain swamps, occasional, *DJR 1368.*

Cladium mariscus (L.) Pohl subsp. *jamaicense* (Crantz) Kükenth., fresh marsh, pine flatwoods, frequent, *DJR 1207.*

Cyperus croceus Vahl., disturbed places, frequent, *DJR 1200.*

Cyperus haspan L., forest swales, frequent, *JMJ 1243.*

Cyperus odoratus L. var. *odoratus*, Intermediate marsh, occasional, *DJR 1672.*

Cyperus polystachyos Rottb., fresh marsh, occasional, *DJR 1259.*

Cyperus pseudovegetus Steud. var. *pseudovegetus*, disturbed places, frequent, *DJR 1085.*

Cyperus retrorsus Chapm., disturbed places, frequent, *DJR 952.*

Cyperus thyrsiflorus Jung., disturbed places, frequent, *DJR 1084.*

Cyperus virens Michx. var. *virens*, disturbed places, Forest swales, frequent, *DJR 1083.*

Eleocharis cellulosa Torr., intermediate marsh, pine flatwoods, frequent, *DJR 896.*

Eleocharis microcarpa Torr. var. *microcarpa*, pine flatwoods, frequent, *DJR 901.*

Eleocharis montevidensis Kunth, palustrine areas, frequent, *DJR 1000.*

Eleocharis obtusa (Willd.) Schult., forest swales, infrequent, *DJR 1026.*

Eleocharis olivacea Torr, fresh marsh mud flats, infrequent, *DJR 1260.*

Eleocharis palustris (L.) R. & S., fresh marsh, abundant, *DJR 1984.*

Eleocharis parvula (R. & S.) Link var. *anachaeta* (Torr.) Svens., fresh and intermediate marsh mud flats, frequent, *DJR 843.*

Eleocharis quadrangulata (Michx.) R. & S., borrow ditches, rare, *DJR 1094.*

Eleocharis tuberculosa (Michx.) R. & S., pine flatwoods, frequent, *DJR 897.*

Fimbristylis caroliniana (Lam.) Fern., pine flatwoods, frequent, *DJR 1249*.

Fimbristylis castanea (Michx.) Vahl., intermediate marsh, frequent, *DJR 922*.

Fimbristylis dichotoma (L.) Vahl., disturbed places, occasional, *DJR 1219*.

**Fimbristylis miliacea* (L.) M. H. Vahl, disturbed places, occasional, *DJR 1706*.

Furiena breviseta (Cov.) Cov., pine flatwoods, occasional, *DJR 898*.

Isolepis carinata Hook. & Arn. ex Torr. [*Scirpus koilolepis* (Steud.) Gl.], wet, sandy forest roads, frequent, *DJR 1349*.

Kylingia brevifolia Rottb., disturbed places, infrequent, *DJR 1049*.

Rhynchospora caduca Ell., mixed woods, frequent, *DJR 1073*.

Rhynchospora cephalantha A. Gray, wet clearcuts, frequent, *DJR 1234*.

Rhynchospora colorata (L.) H. Pfeiffer [*Dichromena colorata* (L.) Hitchc.], pine flatwoods, occasional, *DJR 912*.

Rhynchospora corniculata (Lam.) A. Gray, pine flatwoods, forest swales, frequent, *JMJ 1321*.

Rhynchospora debilis Gale, bogs, frequent, *DJR 1655*.

Rhynchospora elliottii D. Dietr., wet clearcuts, frequent, *DJR 1233*.

Rhynchospora fascicularis (Michx.) Vahl, pine flatwoods, frequent, *DJR 888*.

Rhynchospora gracilenta A. Gray, wet clearcuts, frequent, *DJR 1235*.

Rhynchospora inexpansa (Michx.) Vahl, pine flatwoods, frequent, *DJR 890*.

Rhynchospora perplexa Britt., wet clearcuts, frequent, *DJR 1116*.

Rhynchospora rariflora (Michx.) Ell., wet clearcuts, occasional, *DJR 1120*.

Schoenoplectus americanus (Pers.) Volk. [*Scirpus americanus* Pers.], fresh marsh, frequent, *DJR 1082*.

Schoenoplectus tabernaemontani (K. C. Gmel.) Palla [*Scirpus validus* Vahl], fresh marsh, frequent, *DJR 1081*.

Scleria oligantha Michx., oak hickory ridge, infrequent, *DJR 1029*.

Scleria pauciflora Muhl. ex Willd. var. *pauciflora*, pine savanna, occasional, DJR 1955.

Scleria triglomerata Michx., wet clearcuts, frequent, *DJR 951*.

Scleria verticillata Muhl. ex Willd., longleaf pine savanna, infrequent, *DJR 1697*.

ERIOCAULACEAE

Eriocaulon decangulare L., bogs, occasional, *JMJ 1320*.

HYDROCHARITACEAE

Vallisneria americana Michx., bayous, roadside canals, occasional, *DJR 2005*.

HYPOXIDACEAE

Hypoxis curtissii Rose, floodplain swamps, infrequent, *DJR 1997*.

Hypoxis hirsuta (L.) Cov., roadsides, infrequent, *DJR 990*.

IRIDACEAE

Iris hexagona Walt., borrow ditches, frequent, *DJR 1015*.

Iris virginica L., gum swamps, forest swales, bayou edges, frequent, *JMJ 1297*.

Sisyrinchium atlanticum Bickn., roadsides, frequent, *DJR 1009*.

**Sisyrinchium exile* Bickn., disturbed places, frequent, *DJR 1012*.

JUNCACEAE

Juncus brachycarpus Engelm., pine flatwoods, occasional, *DJR 2007*.

Juncus bufonius L., spoil levees, occasional, *DJR 1408*.

Juncus coriaceus Mack., forest swales, occasional, *DJR 1732*.

Juncus diffusissimus Buckl., borrow ditches, occasional, *DJR 1088*.

Juncus effusus L., borrow ditches, frequent, *DJR 1016*.

Juncus elliottii Chapm., wet clearcuts, frequent, *DJR 1010*.

Juncus marginatus Rostk., disturbed places, occasional, *DJR 1047*.

Juncus polycephalus Michx., borrow ditches, frequent, *DJR 1093*.

Juncus repens Michx., forest swales, occasional, *DJR 1197*.

Juncus roemerianus Scheele, intermediate marsh, abundant, *DJR 986*.

Juncus tenuis willd. var. *dichotomus* (Ell.) Wood, forest swales, occasional, DJR 1982.

Juncus tenuis Willd. var. *tenuis*, forest swales, frequent, *DJR 1994*.

LEMNACEAE

Lemna minor L., gum swamps, frequent, *DJR 1063.*

NAJADACEAE

Najas guadalupensis (Spreng.) Magnus, Cane Bayou canoe launch, frequent, *DJR 1203.*

ORCHIDACEAE

Spiranthes odorata (Nutt.) Lindl., gum swamps, infrequent, *DJR 1745.*

Spiranthes praecox (Walt.) S. Wats., beech magnolia woods, occasional, *JMJ 1312.*

POACEAE

Agrostis hyemalis (Walt.) B.S.P., roadsides, occasional, *DJR 1068.*

Andropogon glomeratus (Walt.) B.S.P. var. *glaucopsis* (Ell.) Mohr, longleaf pine savanna, frequent, *DJR 1664.*

Andropogon glomeratus (Walt.) B.S.P. var. *pumilus* Vasey, longleaf pine savanna, frequent, *DJR 1685*

Andropogon gyrans Ashe var. *stenophyllus* (Hack.) C. Campb., longleaf pine savanna, frequent, *DJR 1676.*

Andropogon virginicus L. var. *virginicus*, mixed woods, clearcuts, abundant, *DJR 1684.*

Anthaenantia rufa (Ell.) Schult., bogs, infrequent, *DJR 948.*

Aristida longespica Poir. var. *geniculata* (Raf.) Fern., longleaf pine savanna, occasional, *DJR 893.*

Arundinaria gigantea (Walt.) Muhl. subsp. *gigantea*, mixed woods, occasional, *DJR 1423.*

Axonopus fissifolius (Raddi) Kuhlm., pine flatwoods, occasional, *DJR 899.*

**Briza minor* L., roadsides, frequent, *DJR 1014.*

**Bromus catharticus* Vahl, disturbed places, frequent, *DJR 1039.*

Chasmanthium laxum (L.) Yates var. *laxum*, mixed woods, beech magnolia woods, abundant, *DJR 1206.*

Chasmanthium laxum (L.) H. Yates var. *sessiliflorum* (Poir.) Wipff & S. D. Jones, mixed woods, infrequent, *DJR 1731.*

Ctenium aromaticum (Walt.) Wood, bogs, infrequent, *DJR 947.*

**Cynodon dactylon* (L.) Pers., disturbed places, frequent, *DJR 1031.*

Digitaria ciliaris (Retz.) Koel, roadsides, frequent, *DJR 1220.*

Distichlis spicata (L.) Greene, intermediate marsh, frequent, *JMJ 1334.*

**Echinochloa crus-galli* (L.) Beauv. var. *crus-galli*, fresh marsh, occasional *DJR 1268.*

Elymus virginicus L. var. *virginicus*, roadsides, occasional, *DJR 1108.*

Eragrostis elliottii S. Wats., pine flatwoods, occasional, *DJR 895.*

Eragrostis hypnoides (Lam.) B.S.P., gum swamps, frequent, *DJR 1271.*

Eragrostis spectabilis (F. Pursh) E. von Steudel, longleaf pine savanna, infrequent, *DJR 1666.*

**Eremochloa ophiuroides* (Munro) Hack., disturbed places, frequent, *JMJ 1340.*

Hordeum pusilum Nutt., roadsides, frequent, *DJR 1001.*

Imperata brasiliensis* (L.) Beauv., roadsides, occasional, *DJR 1034.* **Federal noxious weed

Leersia hexandra Sw., borrow ditches, occasional, *JMJ 1332.*

Leersia lenticularis Michx., forest swales, occasional, *DJR 1718.*

Leersia oryzoides (L.) Sw., borrow ditches, infrequent, *DJR 1741.*

Leersia virginica Willd., mixed woods, occasional, *DJR 1742.*

Leptochloa fusca (L.) Kunth subsp. *fascicularis* (Lam.) N. Snow., intermediate and fresh marsh, frequent, *DJR 1673.*

**Lolium arundinaceum* (Schreb.) S. J. Darbyshire [*Festuca arundinacea* Schreb.], roadsides, occasional, *DJR 1087.*

**Lolium perenne* L., disturbed places, frequent, *DJR 1091.*

Melica mutica Walt., disturbed roadside, occasional, *DJR 1419.*

Muhlenbergia expansa (Poir.) Trin., pine savanna, infrequent, *DJR 946.*

Oplismenus hirtellus (L.) Beauv., oak hickory ridge, frequent, *DJR 931.*

Panicum aciculare Desv. *ex* J. Poiret var. *angustifolium* (Ell.) Wipff & S. D. Jones., mixed woods, frequent, *DJR 1414.*

Panicum acuminatum Sw. var. *acuminatum*, oak hickory ridge, infrequent, *DJR 1023.*

Panicum acuminatum SW. var. *fasciculatum* (Torr.) Lelong., mixed woods, frequent, *DJR 1345.*

Panicum anceps Michx., wet clearcuts, infrequent, *DJR 954.*

Panicum boscii J. Poiret, beech magnolia woods, frequent, *DJR 1976*.
Panicum commutatum Schult. var. *joorii* (Vasey) Fern., mixed woods, frequent, *DJR 1378*.
Panicum consanguineum Kunth, mixed woods, frequent, *DJR 1343*.
Panicum dichotomiflorum Michx. subsp. *dichotomiflorum*, disturbed sites, infrequent, *DJR 1659*.
Panicum dichotomum C. Linnaeus var. *lucidum* (Ashe) Lelong, beech magnolia woods, frequent, *DJR 1373*.
Panicum dichotomum L. var. *ramulosum* (Torr.) Lelong, oak hickory ridge, infrequent, *DJR 1396*.
Panicum dichotomum L. var. *roanokense* (Ashe) Lelong, mixed woods, frequent, *DJR 1346*.
Panicum gymnocarpon Ell., floodplain swamps, occasional, *DJR 1737*.
Panicum hians Ell., roadsides, occasional, *DJR 1069*.
Panicum laxiflorum Lam., oak hickory ridge, occasional, *DJR 1375*.
Panicum portoricense Desv. ex Hamilt. var. *nashianum* (Scribn.) Lelong, mixed woods, frequent, *DJR 1347*.
Panicum repens L., wet clearcuts, borrow ditches, abundant, *DJR 1236*.
Panicum rigidulum Nees. var. *rigidulum*, pine flatwoods, occasional, *DJR 1747*.
Panicum rigidulum Nees var. *pubescens* (Vasey) Lelong, longleaf pine savanna, infrequent, *DJR 1691*.
Panicum scoparium Lam., mixed Forests, frequent, *DJR 1193*.
Panicum sphaerocarpon Ell., disturbed sites, frequent, *DJR 1411*.
Panicum verrucosum Muhl., pine flatwoods, wet clearcuts, frequent, *DJR 905*.
Panicum virgatum L., intermediate marsh, pine flatwoods, frequent, *DJR 1239*.
**Parapholis incurva* (L.) C. Hubbard, spoil levees, frequent, *DJR 1416*.
Paspalum conjugatum Berg., disturbed places, frequent, *DJR 1269*.
**Paspalum dilatatum* Poir., disturbed places, frequent, *DJR 1114*.
Paspalum dissectum (L.) L., gum swamps, frequent, *DJR 1210*.
Paspalum floridanum Michx. var. *floridanum*, pine flatwoods, occasional, *DJR 891*.
Paspalum floridanum Michx. var. *glabratum* Engelm. ex Vasey, roadsides, frequent, *DJR 1237*.
Paspalum laeve Michx., pine flatwoods, occasional, *DJR 892*.
Paspalum lividum Trin., borrow ditches, frequent, *DJR 1248*.
**Paspalum notatum* Flüggé, disturbed places, occasional, *JMJ 1326*.
Paspalum plicatulum Michx. var. *plicatulum*, pine flatwoods, occasional, *DJR 1097*.
Paspalum praecox Walt., wet clearcuts, occasional, *DJR 949*.
Paspalum setaceum Michx., longleaf pine savanna, frequent, *DJR 1678*.
**Paspalum urvillei* Steud., disturbed places, occasional, *DJR 900*.
Paspalum vaginatum Sw., spoil levees, frequent, *DJR 1716*.
Phalaris angusta Nees ex Trin., disturbed roadsides, infrequent, *DJR 1402*.
Phalaris caroliniana Walt., disturbed areas, infrequent, *DJR 1412*.
Phragmites communis Trin., along canals, occasional, *DJR 1749*.
**Poa annua* L., roadsides, frequent, *DJR 981*.
**Polypogon monspeliensis* (L.) Desf., disturbed areas, frequent, *DJR 1090*.
Saccharum baldwinii Spreng. [*Erianthus strictus* Baldw.], mixed woods, frequent, *DJR 936*.
Saccharum giganteum (Walt.) Pers. [*Erianthus giganteus* (Walt.) Muhl.], mixed woods, frequent, *DJR 1656*.
Schizachyrium scoparium (Michx.) Nash. var. *scoparium*, pine flatwoods, mixed woods, frequent, *DJR 1662*.
Setaria parviflora (Poir.) Kerguélen, roadsides, frequent, *DJR 1112*.
**Sorghum halepense* (L.) Pers., disturbed places, occasional, *DJR 1205*.
Spartina alterniflora Lois., Intermediate marsh, occasional, *DJR 956*.
Spartina cynosuroides (L.) Roth, intermediate marsh, infrequent, *DJR 1231*.
Spartina patens (Ait.) Muhl., pine flatwoods, intermediate marsh, abundant, *DJR 923*.
Sphenopholus obtusata (Michx.) Scribn., roadsides, frequent, *DJR 979*.

Sporobolus indicus (L.) R. Br., roadsides, frequent, *DJR 1005*.

Sporobolus virginicus (L.) Kunth, spoil levees, frequent, *DJR 1713*.

**Stenotaphrum secundatum* (Walt.) O. Ktze., disturbed places, frequent, *JMJ 1341*.

Tridens ambiguus (Ell.) Schult., pine flatwoods, occasional, *DJR 902*.

Tridens flavus (L.) Hitchc. var. *flavus*, disturbed roadsides, infrequent, *DJR 1750*.

Tridens strictus (Nutt.) Nash, pine flatwoods, occasional, *DJR 903*.

Tripsacum dactyloides (L.) L. var. *dactyloides*, disturbed roadsides, infrequent, *DJR 1201*.

Vulpia octoflora (Walt.) Rydb. var. *octoflora*, disturbed areas, occasional, *DJR 1409*.

Zizaniopsis miliacea (Michx.) Doell & Asch., borrow ditches, fresh marsh, frequent, *DJR 1052*.

PONTEDERIACEAE

Pontederia cordata L., borrow ditches, frequent, *DJR 1070*.

POTAMOGETONACEAE

Potamogeton diversifolius Raf, small lake at Boy Scout Road, infrequent, *DJR 1428*.

RUPPIACEAE

Ruppia maritima L., Bayou Lacombe, marsh ponds, frequent, *JMJ 1292*.

SMILACACEAE

Smilax bona-nox L., mixed woods, infrequent, *DJR 1011*.

Smilax glauca Walt., mixed woods, occasional, *DJR 1352*.

Smilax laurifolia L., bogs, occasional, *DJR 1951*.

Smilax pumila Walt., mixed woods, occasional, *DJR 1385*.

Smilax rotundifolia L., floodplain swamps, mixed woods, frequent, *DJR 970*.

Smilax smallii Morong, mixed woods, frequent, *DJR 1351*.

Smilax tamnoides L., mixed woods, occasional, *DJR 1954*.

Smilax walteri Pursh, beech magnolia woods, occasional, *DJR 1363*.

TYPHACEAE

Typha latifolia L., fresh marsh, borrow ditches, frequent, *DJR 1222*.

XYRIDACEAE

Xyris ambigua Beyr. ex Kunth, pine savanna, occasional, *JMJ 1247*.

Xyris laxifolia Mart. var. *iridifolia* (Chapm.) Kral, pine savanna, occasional, *DJR 1710*.

Xyris stricta Chapm., pine savanna, frequent, *DJR 1198*.

ZANNICHELLIACEAE

Zannichellia palustris L., Bayou Lacombe, marsh ponds, frequent, *JMJ 1293*.

MAGNOLIOPSIDA

ACANTHACEAE

Ruellia humilis Nutt., disturbed places, occasional, *DJR 1053*.

ACERACEAE

Acer rubrum L. var. *drummondii* (Hook. & Arn. ex Nutt.) Sarg., floodplain swamps, forest swales, frequent, *JMJ 1259*.

Acer rubrum L. var. *rubrum*, beech magnolia woods, occasional, *DJR 1359*.

Acer rubrum L. var. *trilobum* Torr. & A. Gray ex K. Koch., forest swales, occasional, *DJR* sight record.

AMARANTHACEAE

**Alternanthera philoxeroides* (Mart.) Griseb., borrow ditches, fresh marsh, frequent, *DJR 915*.

**Amaranthus* cf. *cannabinus* (L.) Sauer, fresh marsh, abundant, *DJR 1264*.

ANACARDIACEAE

Rhus copallinum L., mixed woods, frequent, *DJR 1255*.

Toxicodendron radicans (L.) Kuntze, throughout, abundant, *DJR 2006*.

APIACEAE

**Centella erecta* (L. f.) Fern., pine flatwoods, wet clearcuts, frequent, *JMJ 1220*.

Chaerophyllum tainturieri Hook., disturbed roadsides, occasional, *DJR 1381*.

**Cyclospermum leptophyllum* (Pers.) Sprag. ex Britt. & P. Wils., roadsides, frequent, *DJR 980*.

Eryngium yuccifolium Michx., pine flatwoods, frequent, *DJR 1199*.

Hydrocotyle verticillata Thunb., palustrine areas, frequent, *DJR 1042*.

Oxypolis filiformis (Walt.) Britt., pine flatwoods, occasional, *DJR 1258*.

Ptilimnium capillaceum (Michx.) Raf., floodplain swamps, fresh marsh, frequent, *DJR 2000.*
Sanicula canadensis L., mixed woods, frequent, *DJR 1046.*

APOCYNACEAE

Trachelospermum difforme (Walt.) A.Gray., mixed woods, frequent, *DJR 1337.*

AQUIFOLIACEAE

Ilex cassine L., wet woods, very rare, *DJR 909.*
Ilex decidua T. Walter, wet woods, rare, *DJR 1987.*
Ilex glabra (L.) A. Gray, mixed woods, occasional, *DJR 1348.*
Ilex myrtifolia Walt., mixed woods, frequent, *DJR 1652.*
Ilex opaca Ait., mixed woods, occasional, *DJR 994.*
Ilex verticillata (L.) A. Gray, floodplain swamps, infrequent, *DJR 1989.*
Ilex vomitoria Ait., mixed woods, frequent, *DJR 993.*

ARALIACEAE

Aralia spinosa L., oak hickory ridge, frequent, *JMJ 1344.*

ARISTOLOCHIACEAE

Aristolochia serpentaria L., beech magnolia woods, infrequent, *DJR 1978.*

ASCLEPIADACEAE

Asclepias lanceolata Walt., pine flatwoods, frequent, *JMJ 1304.*
Asclepias longifolia Michx., bogs, infrequent, *DJR 1957.*
Cynanchum angustifolium Pers., pine flatwoods, intermediate marsh, frequent, *DJR 1109.*
Matelea gonocarpos (Walt.) Shinners, beech magnolia woods, infrequent, *JMJ 1301.*

ASTERACEAE

Acmella oppositifolia (Lam.) R. Jansen var. *repens* (Walt.) R. Jansen, disturbed roadsides, occasional, *DJR 1738.*
Ambrosia artemisifolia L., disturbed roadsides, frequent, *JMJ 1345.*
Baccharis angustifolia Michx, pine flatwoods, occasional, *DJR 928.*
Baccharis halimifolia L., disturbed roadsides, pine flatwoods, frequent, *DJR 925.*
Baldunia uniflora Nutt., bogs, infrequent, *DJR 944.*
Bidens aristosa (Michx.) N. Britton, forest swales, occasional, *DJR 1708.*
Bidens mitis (Michx.) Sherff, wet clearcuts, infrequent, *DJR 942.*
Bigelowia nudata (Michx.) DC., pine flatwoods, frequent, *DJR 906.*
Boltonia asteroides (L.) L'Her., pine flatwoods, occasional, *DJR 926.*
Boltonia diffusa Ell., pine flatwoods, occasional, *DJR 1668.*
Carphephorus odoratissimus (J. F. Gmel.) Cass., wet clearcuts, infrequent, *JMJ 1242.*
Carphephorus pseudoliatris Cass., wet clearcuts, occasional, *DJR 945.*
Cirsium horridulum Michx., roadsides, abundant, *JMJ 1262.*
Conoclinum coelestinum (L.) DC. [*Eupatorium coelestinum* L.], roadsides, frequent, *DJR 927.*
**Conyza bonariensis* (L.) Cronq., disturbed roadsides, occasional, *DJR 1277.*
Conyza canadensis (L.) Cronq., spoil levees, infrequent, *DJR 1715.*
Eclipta prostrata (L.) L., borrow ditches, frequent, *DJR 916.*
Elephantopus carolinianus Raeusch., mixed woods, frequent, *DJR 1687.*
Elephantopus elatus Bert., mixed woods, occasional, *DJR 1696.*
Elephantopus nudatus A. Gray, mixed woods, occasional, *DJR 1688.*
Erigeron philadelphicus L., roadsides, occasional, *JMJ 1257.*
Erigeron vernus (L.) Torr. & A. Gray, pine savanna, occasional, *DJR 1956.*
Eupatorium capillifolium (Lam.) Small, disturbed roadsides, waste places, frequent, *JMJ 1227.*
Eupatorium leucolepis (DC.) Torr. & A. Gray, pine savanna, occasional, *JMJ 1225.*
Eupatorium perfoliatum L., mixed woods, occasional, *DJR s.n.*
Eupatorium rotundifolium L., pine flatwoods, occasional, *DJR 1273.*
Eupatorium serotinum Michx., mixed woods, occasional, *DJR* sight record.
Euthamia gymnospermoides Greene, mixed woods, occasional, *DJR 1675.*
Euthamia leptocephala (Torr. & A. Gray) Greene, pine flatwoods, frequent, *DJR 934.*
Gamochaeta purpurea (L.) Cabrera [*Gnaphalium purpureum* L.], waste places, frequent, *DJR 1040.*

Helenium amarum (Raf.) Rock, disturbed road sides, frequent, *JMJ 1226.*

Helenium flexuosum Raf., roadsides, pine flatwoods, frequent, *DJR 1067.*

Helianthus angustifolius L., pine savanna, frequent, *DJR 941.*

Helianthus heterophyllus Nutt., pine savanna, occasional, *DJR 943.*

*Hypochaeris microcephala (Sch. Bip.) Cabrera var. albiflora (O. Ktze.) Cabrera, roadsides, occasional, DJR 2002.

Iva annua L., disturbed roadsides, frequent, *DJR 1262.*

Iva frutescens L., intermediate marsh, roadsides, abundant, *DJR 1242.*

Krigia caespitosa (Raf.) Chambers, roadsides, frequent, *DJR 1003.*

Mikania scandens (L.) Willd., pine flatwoods, occasional, *JMJ 1231.*

Packera glabella (J. Poiret) C. Jeffrey [*Senecio glabellus* J. Poiret], disturbed areas, infrequent, *DJR 1406.*

Pityopsis graminifolia (Michx.) Nutt., hummocks on marsh edge, occasional, *DJR 1698.*

Pluchea rosea Godfrey, roadsides, frequent, *DJR 1245.*

Pyrrhopappus pauciflorus (D. Don) DC., roadsides, occasional, *DJR 1078.*

Solidago arguta Ait., pine flatwoods, occasional, *JMJ 1223*

Solidago canadensis L. var. *scabra* (Muhl. ex Willd.) Torr. & A. Gray, disturbed places, occasional, *DJR 1722.*

Solidago rugosa Mill., oak hickory ridge, frequent, *JMJ 1237.*

Solidago sempervirens L., intermediate marsh, pine flatwoods, occasional, *JMJ 1305.*

**Soliva sessilis* R. & P., disturbed places, frequent, *DJR 1963.*

**Sonchus asper* (L.) Hill, rodsides, frequent, *DJR 976.*

Stokesia laevis (Hill) Greene, pine savanna, infrequent, *JMJ 1249.*

Symphyotrichum divaricatum (Nutt.) Nesom [*Aster divaricatus* (Nutt.) Torr. & A. Gray], mixed woods, frequent, *DJR 1669.*

Symphyotrichum dumosum (L.) Nesom [*Aster dumosus* L.], pine flatwoods, occasional, *DJR 933.*

Symphyotrichum lateriflorum (L.) Löve & Löve [*Aster lateriflorus* (L.) Britt.], mixed woods, occasional, *DJR s.n.*

Symphyotrichum patens (Ait.) Nesom [*Aster patens* Ait.], mixed woods, frequent, *DJR 1699.*

Symphyotrichum praealtum (Poir.) Nesom [*Aster praealtus* Poir.], mixed woods, frequent, *DJR 1667.*

Symphyotrichum subulatum (Michx.) Nesom [*Aster subulatus* Michx.], pine flatwoods, frequent, *DJR 924.*

Symphyotrichum tenuifolium (L.) Nesom [*Aster tenuifolius* L.], intermediate Marsh, frequent, *DJR 957.*

**Taraxacum officinale* G.H. Weber ex Wiggers, roadsides, common, *JMJ 1255.*

Verbesina virginica L., roadsides, frequent, *DJR* sight record.

Xanthium strumarium L., roadsides, infrequent, *DJR 1711.*

**Youngia japonica* (L.) DC., roadsides, frequent, *DJR 973.*

BETULACEAE

Carpinus caroliniana Walt., mixed woods, beech magnolia woods, frequent, *DJR 1079.*

BIGNONIACEAE

Bignonia capreolata L., mixed woods, frequent, *DJR 997.*

Campsis radicans (L.) Seem. ex Bur., mixed woods, frequent, *JMJ 1325.*

BORAGINACEAE

**Heliotropium indicum* L., gum swamps, frequent, *DJR 1209.*

Myosotis macrosperma Engelm., mixed woods, frequent, *DJR 1050.*

BRASSICACEAE

Lepidium virginicum L., disturbed places, occasional, *DJR 1048.*

Rorippa palustris (L.) Bess. subsp. *fernaldiana* (Butt. & E. Abbe) B.E. Jonsell, roadsides, occasional, DJR 2001.

BUDDLEJACEAE

Polypremum procumbens L., pine flatwoods, roadsides, occasional, *DJR 1251.*

CALLITRICHACEAE

Callitriche heterophylla Pursh., borrow ditches, occasional, *DJR 1389.*

CAMPANULACEAE

Lobelia brevifloia Nutt. ex A. DC., longleaf pine savanna, occasional, *DJR 1681.*

Lobelia puberula Michx., oak hickory ridge, pine flatwoods, occasional, *JMJ 1234.*

Lobelia spicata Lam., beech magnolia woods, occasional, *DJR 1730.*

Triodanus perfoliata (L.) Nieuw., roadsides, frequent, *DJR 1043.*

CAPRIFOLIACEAE

**Lonicera japonica* Thunb., oak hickory ridge, occasional, *JMJ 1276.*

Sambucus canadensis L., disturbed roadsides, occasional, *DJR 1105.*

Viburnum dentatum L., oak hickory ridge, mixed woods, frequent, *DJR 1107.*

CARYOPHYLLACEAE

**Cerastium glomeratum* Thuill., disturbed roadsides, occasional, *JMJ 1285.*

Spergularia marina (L.) Griseb., spoil levees, frequent, *DJR 1410.*

CERATOPHYLLACEAE

Ceratophyllum demersum L., Cane Bayou canoe launch, frequent, *DJR 1202.*

CISTACEAE

Lechea tenuifolia Michx., frquent, marsh edge, *DJR 1671.*

CLUSIACEAE

Hypericum brachyphyllum (Spach) Steud, pine flatwoods, frequent, *DJR 1247.*

Hypericum cistifolium Lam., pine flatwoods, occasional, *JMJ 1221.*

Hypericum denticulatum Walt., pine flatwoods, occasional, *DJR 1250.*

Hypericum gymnanthum Engelm. & A. Gray, forest swale, occasional, *DJR 1194.*

Hypericum hypericoides (L.) Crantz, oak hickory ridge, frequent, *JMJ 1238.*

CONVOLVULACEAE

Calystegia sepium (L.) R.Br., roadsides, occasional, *JMJ 1313.*

Dichondra carolinensis Michx., waste places, frequent, *DJR 1044.*

Ipomoea sagitata Poir., intermediate marsh, frequent, *DJR 1229.*

CORNACEAE

Cornus foemina Mill, floodplain swamps, frequent, *DJR 1438.*

CUCURBITACEAE

Melothria pendula L., disturbed Forest, occasional, *DJR 1422.*

CUSCUTACEAE

Cuscuta indecora Choisy, intermediate marsh, abundant, *JMJ 1335.*

DROSERACEAE

Drosera capillaris Poir. var. *capillaries*, bogs, frequent, *DJR 1959.*

EBENACEAE

Diospyros vriginiana L., mixed woods, frequent, *DJR 1035.*

ERICACEAE

Rhododendron viscosum (L.) Torr., floodplain swamps, infrequent, *DJR 1988.*

Vaccinium arboreum Marsh., oak hickory ridge, occasional, *JMJ 1266.*

Vaccinium corymbosum L., mixed woods, occasional, *DJR 1341.*

Vaccinium stamineum L., mixed woods, occasional, *DJR 1338.*

EUPHORBIACEAE

Croton capitatus Michx. var. *lindheimeri* (Engelm. & A. Gray) J. Muell.-Arg., roadsides, frequent, *DJR 1274.*

Euphorbia humistrata Engelm., roadsides, disturbed places, frequent, *DJR 1243.*

Euphorbia maculata L., roadsides, disturbed places, frequent, *DJR 917.*

Euphorbia prostrata Ait., roadsides, disturbed places, frequent, *JMJ 1229.*

Phyllanthus caroliniensis Walt., gum swamps, frequent, *DJR 1211.*

**Phyllanthus urinaria* L., roadsides, disturbed places, occasional, *DJR 1218.*

**Sapium sebiferum* (L.) Roxb., mixed woods, gum swamps, pine flatwoods, occasional, *DJR 1106.*

FABACEAE

**Albizia julibrissin* I. Durazz., roadsides, infrequent, *DJR 1213.*

Amorpha fruticosa L., floodplains, occasional, *DJR 1075.*

Baptisia alba (L.) Vent. var. *macrophylla* (Larisey) Isely [*Baptisia lactea* (Raf.) Thieret], mixed woods, occasional, *DJR 1076*.

Centrosema virginiatum (L.) Benth., roadsides, frequent, *DJR 1253*.

Chamaecrista fasciculata (Michx.) E. Greene, mixed woods, frequent, *DJR 1689*.

Desmanthus illinoensis (Michx.) MacM., roadsides, frequent, *DJR 1232*.

Desmodium paucíflorum (Nutt.) DC., mixed woods, oak hickory ridge, frequent, *DJR 1058*.

Desmodium sessilifolium Torr. & A. Gray, mixed woods, frequent, *DJR 1694*.

Erythrina herbacea L., mixed woods, oak hickory ridge, frequent, *JMJ 1300*.

Gleditsia triacanthos L., floodplains, frequent, *DJR 1037*.

Lespedeza capitata Michx., mixed woods, frequent, *DJR 1695*.

**Medicago arabica* (L.) Huds., roadsides, frequent, *JMJ 1261*.

**Medicago lupulina* L., roadsides, occasional, *DJR 1981*.

**Melilotus indicus* (L.) All., roadsides, infrequent, *JMJ 1263*.

Neptunia lutea (Leavenw.) Benth., roadsides, frequent, *DJR 1228*.

Sesbania drummondii (Rydb.) Cory, Intermediate marsh, frequent, *DJR 1227*.

**Sesbania punicea* (Cav.) Benth. Floodplains, occasional, *JMJ 1283*.

Tephrosia spicata (Walt.) Torr. & A. Gray, mixed woods, occasional, *DJR 1702*.

**Trifolium campestre* Schreb.var. *campestre*, disturbed places, occasional, *DJR 1983*.

**Trifolium dubium* Sibth, disturbed places, frequent, *DJR 1045*.

**Trifolium repens* L., disturbed places, frequent, *JMJ 1280*.

**Vicia sativa* L., disturbed areas, frequent, *DJR 1413*.

**Vicia tetrasperma* (L.) Schreb., disturbed roadsides, occasional, *JMJ 1282*.

**Vicia villosa* Roth, disturbed roadsides, common, *DJR 1404*.

Vigna luteola (Jacq.) Benth, intermediate marsh, occasional, *JMJ 1299*.

Wisteria frutescens (L.) Poir, mixed woods, occasional, *DJR 1353*.

FAGACEAE

Fagus grandifolia Ehrh., beech magnolia woods, frequent, *DJR 1266*.

Quercus alba L., mixed woods, infrequent, *DJR 1434*.

Quercus falcata Michx. var. *falcata*, mixed woods, beech magnolia woods, frequent, *JMJ 1331*.

Quercus falcata Michx. var. *pagodifolia* Ell., mixed woods, frequent, *DJR 1095*.

Quercus laurifolia Michx., mixed woods, forest swales, frequent, *DJR 995*.

Quercus marilandica Muenchh., hummocks on marsh edge, rare, *DJR 1700*.

Quercus michauxii Nutt., oak hickory ridge, mixed woods, frequent, *DJR 930*.

Quercus nigra L., mixed woods, forest swales, occasional, *DJR 988*.

Quercus phellos L., forest swales, occasional, *DJR 991*.

Quercus similis Ashe, oak hickory ridge, mixed woods, occasional, *DJR 1342*.

Quercus sinuata Walt. var. *sinuata*, forested swales, rare, *DJR 1113*.

Quercus virginiana Mill., mixed woods, occasional, *DJR 989*.

GENTIANACEAE

Centaurium pulchellum (Sw.) Druce, waste places, infrequent, *JMJ 1307*.

Eustoma exaltatum (L.) Salib. ex G. Don., roadsides, occasional, *JMJ 1338*.

Sabatia calycina (Lam.) Heller, roadsides, occasional, *DJR 1071*.

Sabatia dodecandra (L.) B.S.P., roadsides, infrequent, *JMJ 1339*.

GERANIACEAE

Geranium carolinianum L., roadsides, frequent, *DJR 1006*.

GROSSULARIACEAE

Itea virginica L., floodplain swamps, occasional, *DJR 1995*.

HALORAGACEAE

**Myriophyllum* cf. *aquaticum* (Vell.) Verdc., gum swamps, infrequent, *DJR 1430*.

Myriophyllum pinnatum (Walt.) B.S.P., forest swales, frequent, *DJR 985*.

**Myriophyllum sibiricum* Kom., canals, marsh ponds, abundant, *DJR 1748*.

Proserpinaca pectinata Lam., pine savanna, occasional, *DJR 1117*.

HAMAMELIDACEAE

Hamamelis virginiana L., oak hickory ridge, rare, *JMJ 1265*.

Liquidambar styraciflua L., mixed woods, frequent, *DJR 987*.

HIPPOCASTANACEAE

Aesculus pavia L., beech magnolia woods, occasional, *DJR 1357*.

HYDROPHYLLACEAE

Hydrolea ovata Nutt. ex Choisy, palustirne, frequent, *DJR 1254*

JUGLANDACEAE

Carya glabra (Mill.) Sweet, mixed woods, oak hickory ridge, frequent, *DJR 1280*.

Carya illinoiensis (F. von Wangenheim) K. Koch, abandoned homesite, very rare, *JMJ 1281*.

LAMIACEAE

Hyptis alata (Raf.) Shinners, mixed woods, occasional, *DJR* sight record.

Lycopus rubellus C. Moench, forest swales, occasional, *DJR 1709*.

**Micromeria brownei* (Sw.) G. Bentham, roadsides, infrequent, *JMJ 1286*.

**Perilla frutescens* (L.) Britt., mixed woods margins, occasional, *DJR 1064*.

Salvia lyrata L., roadsides, frequent, *JMJ 1258*.

Scutellaria integrifolia L., mixed woods, frequent, *DJR 1056*.

Scutellaria ovata Hill, mixed woods, frequent, *DJR 1096*.

Stachys crenata Raf., roadsides, frequent, *JMJ 1287*.

Stachys floridana Shuttlw. ex Benth., disturbed areas, infrequent, *DJR 1426*.

Teucrium canadense L., mixed woods, infrequent, *JMJ 1346*.

Trichostema dichotomum L., pine savanna, occasional, *DJR 1690*.

LAURACEAE

Persea palustris (C. Rafinesque-Schmaltz Raf.) Sarg., mixed woods, infrequent, *DJR 1405*.

LENTIBULARIACEAE

Utricularia foliosa L., borrow ponds and ditches, occasional, *DJR 1724*.

Utricularia gibba L., borrow ponds and ditches, occasional, *DJR 1665*.

Utricularia purpurea Walt., pine flatwood ponds, borrow ditches, rare, *DJR 850*.

Utricularia radiata Small, borrow ponds and ditches, occasional, *DJR 977*.

Utricularia subulata L., bogs, frequent, *DJR 1960*.

LINACEAE

Linum medium (Planch.) Britt., pine flatwoods, frequent, *JMJ 1310*.

LOGANIACEAE

Gelsemium sempervirens St.-Hil., oak hickory ridge, frequent, *DJR 966*.

Mitreola petiolata (Walt.) Torr. & A. Gray, roadsides, frequent, *DJR 1275*.

LYTHRACEAE

Cuphea carthagenensis (Jacq.) Macbr., roadsides, frequent, *DJR 913*.

Lythrum lineare L., intermediate marsh, frequent, *DJR 1240*.

MAGNOLIACEAE

Magnolia grandiflora L., beech magnolia woods, frequent, *DJR 1204*.

Magnolia virginiana L., pine savanna, occasional, *JMJ 1319*.

MALVACEAE

Hibiscus aculeatus Walt., mixed woods, occasional, *DJR 1256*.

Hibiscus moscheutos L. subsp. *lasiocarpos* (A. Cavanilles) O. Blanchard, fresh marsh, floodplains, frequent, *DJR 1214*.

Kosteletzkya virginica (L.) K. Presl ex A. Gray, intermediate marsh, occasional *JMJ 1228*.

Modiola caroliniana (L.) G. Don, roadsides, occasional, *DJR 1065*.

Sida rhombifolia L., oak hickory ridge, waste places, abundant, *JMJ 1236*.

MELASTOMATACEAE

Rhexia mariana L., pine savanna margins, frequent, *JMJ 1317*.

MORACEAE

Morus rubra L., floodplains, occasional *DJR 1036*.

MYRICACEAE

Morella caroliniensis (Mill.) Small [*Myrica heterophylla* Raf.], mixed woods, occasional, *DJR 1350*.

Morella cerifera (L.) Small [*Myrica cerifera* (L.) Small], mixed woods, pine flatwoods, frequent, *DJR 974*.

NYMPHACEAE

Nuphar advena (Ait.) Ait. [*N. lutea* (L.) J. E. Sm.], borrow ditches, frequent, *DJR 1263.*

Nymphea odorata Ait. var. *odorata*, borrow ponds and ditches, marsh ponds and sloughs, abundant, *DJR 907.*

NYSSACEAE

Nyssa aquatica L., floodplain swamps, frequent, *DJR 1979.*

Nyssa biflora Walt., tupelo gum swamps, Frequent, *JMJ 1311.*

Nyssa sylvatica Marsh., mixed woods, frequent, *DJR 992.*

OLEACEAE

Fraxinus caroliniana Mill., floodplain swamps, occasional, *DJR 1080.*

**Ligustrum sinense* Lour., oak hickory ridge, mixed woods, frequent, *JMJ 1274.*

ONAGRACEAE

Gaura parviflora Dougl. ex Lehm., roadsides, infrequent, *JMJ 1302.*

Ludwigia alterniflora L., pine flatwoods, occasional, *DJR 1272.*

Ludwigia decurrens Walt., forest swales, occasional, *DJR 1707.*

Ludwigia linearis Walt., pine flatwoods, infrequent, *DJR 1257.*

Ludwigia octovalvis (Jacq.) Raven, borrow ditches, frequent, *DJR 1246.*

Ludwigia palustris (L.) Ell., forest swale, infrequent, *DJR 1340.*

Ludwigia pilosa Walt., mixed woods, frequent, *DJR 1653.*

Oenothera laciniata Hill., disturbed roadsides, occasional, *DJR 1403.*

Oenothera speciosa Nutt., disturbed places, occasional, *JMJ 1296.*

OXALIDACEAE

**Oxalis debilis* Kunth, oak hickory ridge, frequent, *DJR 1022.*

Oxalis dillenii Jacq., disturbed roadsides, occasional, *DJR 1382.*

Oxalis stricta L., roadsides, frequent, *JMJ 1254.*

PASSIFLORACEAE

Passiflora lutea L., beech magnolia woods, infrequent, *DJR 1361.*

PHYTOLACCACEAE

Phytolaca americana L., roadsides, waste places, occasional, *JMJ 1330.*

PLANTAGINACEAE

**Plantago lanceolata* L., disturbed areas, infrequent, *DJR 1427.*

**Plantago major* L., roadsides, frequent, *DJR 958.*

Plantago virginica L., roadsides, frequent, *DJR 1077.*

POLYGALACEAE

Polygala cruciata L., bogs, frequent, *GMC s.n.*

Polygala incarnata L., pine savanna, frequent, *JMJ 1324.*

Polygala leptocaulis Torr. & A. Gray, pine savanna, infrequent, *DJR 1115.*

Polygala lutea L., pine savanna, occasional, *JMJ 1219.*

Polygala ramosa Ell., pine savanna, infrequent, *DJR 1118.*

POLYGONACEAE

Brunnichia ovata (Walt.) Shinners, mixed woodls, frequent, *DJR 1362.*

Polygonum caespitosum Bl., swales in oak hickory ridge, frequent, *DJR 929.*

Polygonum densiflorum Meisn., floodplain swamps, frequent, *DJR 1739.*

Polygonum hydropiperoides Michx., mesic swales in oak hickory ridge, occasional, *DJR 1111.*

Polygonum punctatum Ell., fresh marsh, borrow ditches frequent, *DJR 908.*

Polygonum setaceum Baldw., disturbed places, infrequent, *DJR 1733.*

**Rumex conglomeratus* Murr., waste places, infrequent, *JMJ 1288.*

**Rumex crispus* L., disturbed roadside, occasional, *DJR 1394.*

PRIMULACEAE

Samolus valerandi L. subsp. *parviflorus* (Raf.) Hult., roadsides, occasional, *JMJ 1256.*

RANUNCULACEAE

Clematis crispa L., floodplains, infrequent, *JMJ 1333.*

**Ranunculus marginatus* d'Urv., roadsides, frequent, *DJR 1024.*

**Ranunculus platensis* Spreng., roadsides, frequent, *DJR 972.*

Ranunculus pusillus Poir., floodplains, frequent, *DJR 1062.*

**Ranunculus sardous* Crantz, disturbed places, occasional, *DJR 1980.*

Ranunculus sceleratus L. var. *sceleratus*, floodplain swamps, infrequent, *DJR 1998.*

Thalictrum dasycarpum Fisch. & Avé -Lall., disturbed woods, frequent, *DJR 1421.*

RHAMNACEAE

Berchemia scandens (Hill) K. Koch, floodplains, frequent, *DJR 1390.*

ROSACEAE

Crataegus marshallii Eggl., oak hickory ridge, occasional, *JMJ 1277.*

Crataegus opaca Hook. & Arn., forest swales, gum swamps, frequent, *DJR 978.*

Prunus serotina Ehrh., oak hickory ridge, occasional, *JMJ 1264.*

**Rosa bracteata* J. Wendl., mixed woods, occasional, *DJR 1086.*

**Rosa laevigata* Michx., floodplain swamps, occasional, *DJR 1224.*

Rubus argutus Link, mixed woods, frequent, *DJR 998.*

Rubus trivialis Michx., roadsides, mixed woods, frequent, *DJR 975.*

RUBIACEAE

Cephalanthus occidentalis L., floodplain swamps, occasional, *JMJ 1250.*

Diodia teres Walt., roadsides, frequent, *JMJ 1298.*

Diodia virginiana L., pine savanna, occasional, *JMJ 1244.*

Galium aparine L., roadsides, frequent, *DJR 982.*

Galium obtusum J. Bigelow, disturbed places, frequent, *DJR 1966.*

Galium tinctorium (L.) Scop., disturbed places, swamps, frequent, *DJR 1967.*

Galium uniflorum Michx., beech magnolia woods, infrequent, *DJR 1979.*

Mitchella repens L., mixed woods, infrequent, *DJR 1433.*

Oldenlandia uniflora L., roadsides, infrequent, *DJR 1102.*

RUTACEAE

**Poncirus trifoliata* (L.) Raf., disturbed places, abundant, *DJR 1208.*

Zanthoxylum clava-herculis L., disturbed places, infrequent, *DJR 1055.*

SALICACEAE

Salix nigra Marsh., disturbed places, infrequent, *DJR 983.*

SARRACENIACEAE

Sarracenia alata Wood, bogs, rare, *DJR 1952.*

SAURURACEAE

Saururus cernuus L., floodplain swamps, forest swales, frequent, *DJR 1072.*

SCROPHULARIACEAE

Agalinis fasciculata (Ell.) Raf., roadsides, frequent, *JMJ 1232.*

Bacopa caroliniana (Walt.) Robins, borrow ditches, abundant, *JMJ 1309.*

Bacopa monnieri (L.) Penn, mud flats, frequent, *JMJ 1342.*

Gratiola pilosa Michx., pine savanna, occasional, *DJR 1196.*

Gratiola ramosa Walt., palustrine areas, frequent, *DJR 1008.*

Lindernia dubia (L.) Penn, gum swamps, frequent, *DJR 1212.*

**Mazus pumilus* (Burm.) C. van Steenis, oak hickory ridge, infrequent, *DJR 1021.*

Mecardonia acuminata (Walt.) Small, disturbed places, frequent, *DJR 914.*

Mecardonia vandelliodes (Mill.) Small, roadsides, infrequent, *DJR 1030.*

Micranthemum umbrosum (J. F. Gmel.) Blake, mudflats, frequent, *DJR 1061.*

**Scoparia dulcis* L., oak hickory ridge, frequent, *JMJ 1233.*

**Veronica arvensis* L., roadsides, frequent, *JMJ 1289.*

SOLANACEAE

Solanum carolinense L., roadsides, disturbed places, frequent, *DJR 1057.*

STYRACACEAE

Halesia diptera Ellis, beech magnolia woods, occasional, *DJR 1355.*

Styrax americanus Lam., oak hickory ridge, infrequent, *JMJ 1279.*

SYMPLOCACEAE

Symplocos tinctoria (L.) L'Her., beech magnolia woods, occasional *DJR 1267.*

ULMACEAE

Celtis laevigata Willd., floodplains, frequent, *JMJ 1284.*

Planera aquatica (Walt.) J. F. Gmel., floodplain swamps, occasional, *DJR 1440*.

Ulmus alata Michx., beech magnolia woods, infrequent, *DJR 1736*.

URTICACEAE

Boehmeria cylindrica (L.) Sw., roadsides, frequent, *DJR 1244*.

VALERIANACEAE

Valerianella radiata (L.) Dufr., roadsides, frequent, *DJR 1004*.

VERBENACEAE

Callicarpa americana L., oak hickory ridge, frequent, *JMJ 1235*.

**Lantana camara* L., roadsides, infrequent, *DJR 1092*.

Phyla nodiflora (L.) Greene, roadsides, frequent, *DJR 911*.

**Verbena brasiliensis* Vell., waste places, roadsides frequent, *JMJ 1306*.

Verbena halei Small, disturbed places, occasional, *JMJ 1295*.

**Verbena rigida* Spreng., disturbed places, occasional, *JMJ 1316*.

Verbena urticifolia L., roadsides, occasional, *DJR 1276*.

VIOLACEAE

Viola lanceolata L., pine savanna, frequent, *DJR 971*.

Viola palmata L. var. *trilobata* (Schwein.) Gingins ex DC., beech magnolia woods, occasional, *DJR 1969*.

Viola primuifolia L., oak hickory ridge, frequent, *DJR 964*.

Viola sororia Willd. var. *sororia*, oak hickory ridge, frequent, *DJR 965*.

VITACEAE

Ampelopsis arborea (L.) Köehne, mixed woods, frequent, *DJR s.n.*

**Cayratia japonica* (Thunb.) Gagnepain, waste places, rare, *DJR 1226*.

Parthenocissus quinquefolia (L.) Planch., mixed woods, frequent, *DJR 1395*.

Vitis astivalis Michx., mixed woods, frequent, *DJR 1339*.

Vitis cinerea (Engelm.) Engelm. ex Millardet, mixed woods, occasional, *DJR 1354*.

Vitis palmata Vahl, oak hickory ridge, occasional, *DJR 1400*.

Vitis rotundifolia Michx., oak hickory ridge, frequent, *JMJ 1278*.

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THE VASCULAR FLORA OF THE OGALLALA ECOTONE ON THE DEMPSEY DIVIDE, ROGER MILLS COUNTY, OKLAHOMA

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ABSTRACT

A floristic inventory of the 3,755-ha Thurmond Ranch and immediate vicinity, located in southern Roger Mills County, Oklahoma, was conducted in 2001. Because of its unusual geologic and topographic setting, which has given rise to a heterogeneous environment and long history of human habitation, the site has been the subject of intense archeological and paleoclimatological research since the early 1980s. The inventory documented 85 families, 286 genera, and 470 species of vascular plants in the study area. The five most species-rich families, Asteraceae, Poaceae, Fabaceae, Euphorbiaceae, and Cyperaceae, collectively account for 51% of the species. Non-native species constitute 10% of the total flora. Four North American species probably were introduced by Euro-Americans, and Native Americans may have introduced three species. Populations of four species tracked by the Oklahoma Natural Heritage Inventory were discovered, and *Epilobium leptophyllum* is reported for the first time in Oklahoma. Collection data show a marked floristic difference between the Tertiary Ogallala Formation and the Permian redbeds along the ecotone. Nineteen major vegetation alliances were identified based on observational data, including three woodland alliances, seven shrubland alliances, and eight herbaceous alliances. Mixed-grass prairie plant communities dominate the study area landscape.

RESUMEN

Se realizó un inventario florístico de las 3,755-ha del Thurmond Ranch y alrededores, localizado en el sur del condado de Roger Mills, Oklahoma, en 2001. Debido a las inusuales características geológicas y topográficas, que dieron lugar a un ambiente heterogéneo y larga historia de ocupación humana, el lugar ha sido objeto de intensa investigación arqueológica y paleoclimatológica desde principio de los 1980. El inventario documentó 85 familias, 286 géneros, y 470 especies de plantas vasculares en el área de estudio. Las cinco familias más ricas, Asteraceae, Poaceae, Fabaceae, Euphorbiaceae, y Cyperaceae, tienen conjuntamente el 51% de las especies. Las especies no nativas comprenden el 10% de la flora total. Cuatro especies norteamericanas fueron introducidas probablemente por Euro-Americanos, y los nativos americanos puede que hayan introducido tres especies. Se descubrieron

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poblaciones de cuatro especies seguidas por el Oklahoma Natural Heritage Inventory, y *Epilobium leptophyllum* se cita por primera vez en Oklahoma. Los datos de colección muestran una clara diferencia florística entre la formación terciaria de Ogallala y las capas sedimentarias rojizas del pérmico a lo largo del ecotono. Se identificaron diecinueve alianzas de vegetación basadas en datos de observación, que incluyen tres alianzas arbóreas, siete arbustivas, y ocho herbáceas. Las comunidades mixtas de pradera dominan el paisaje del área de estudio.

INTRODUCTION

The name "Dempsey Divide" was coined by Thurmond (1990) to refer to the uplands between the Washita and North Fork of the Red Rivers in western Oklahoma. Unusual geologic and topographic conditions in the area have given rise to a heterogeneous environment, an ecology and biota that are distinctive in the southern Great Plains, and a long history of human habitation. Consequently, the Dempsey Divide has been the subject of intense archeological and paleoclimatological research since the early 1980s (Bement 2000; Bement & Buehler 1994, 1998; Buehler 1997; Thurmond 1990, 1991a, 1991b, 1991c, 1997; Thurmond & Picarella 1999; Thurmond et al. 1998; Thurmond & Wyckoff 1998, 1999, 2001). To complement that work, a floristic investigation of the Dempsey Divide was conducted in 2001. The primary objective was to document all native and naturalized vascular plants growing in the area. A secondary objective was to gather baseline data about the plant communities present. This paper summarizes the results of that work.

Study Area

Most of the research described here was conducted on the Thurmond Ranch, a 3,755-ha, contiguous block in southern Roger Mills County, Oklahoma (Fig. 1). The ranch is southwest of Cheyenne, the county seat, and is situated at the southeast edge of the High Plains physiographic province (Bruner 1931). It is on the north side of the Dempsey Divide and extends from the crest of the divide northward to the edge of the Washita River valley.

Brokenleg, Plum, and Sergeant Major Creeks, three short, north-flowing, steep-gradient tributaries of the Washita River, drain the western, northern, and central parts of the ranch, respectively. Killough Creek and Higgins Creek, tributaries of Sergeant Major Creek, traverse the eastern part. These streams have incised a dense, dendritic drainage network on the north side of the divide, creating a canyon system characterized by arroyo cut-and-fill cycles (Schumm & Hadley 1957) operating on centennial and millennial time scales. The most recent incision cycle began around the turn of the 20th Century, triggered by the intense land use of the early post-1892 white settlement period. Maximum elevation on the ranch is 732 m above sea level in the southwest corner. Miminum elevation is 601 m in the northeast corner along Sergeant Major Creek.

The climate of west-central Oklahoma is continental and typified by marked seasonal variation (Curry 1970). Annual annual precipitation at Elk City, roughly 25 km southeast of the ranch, is 57 cm (Oklahoma Climatological

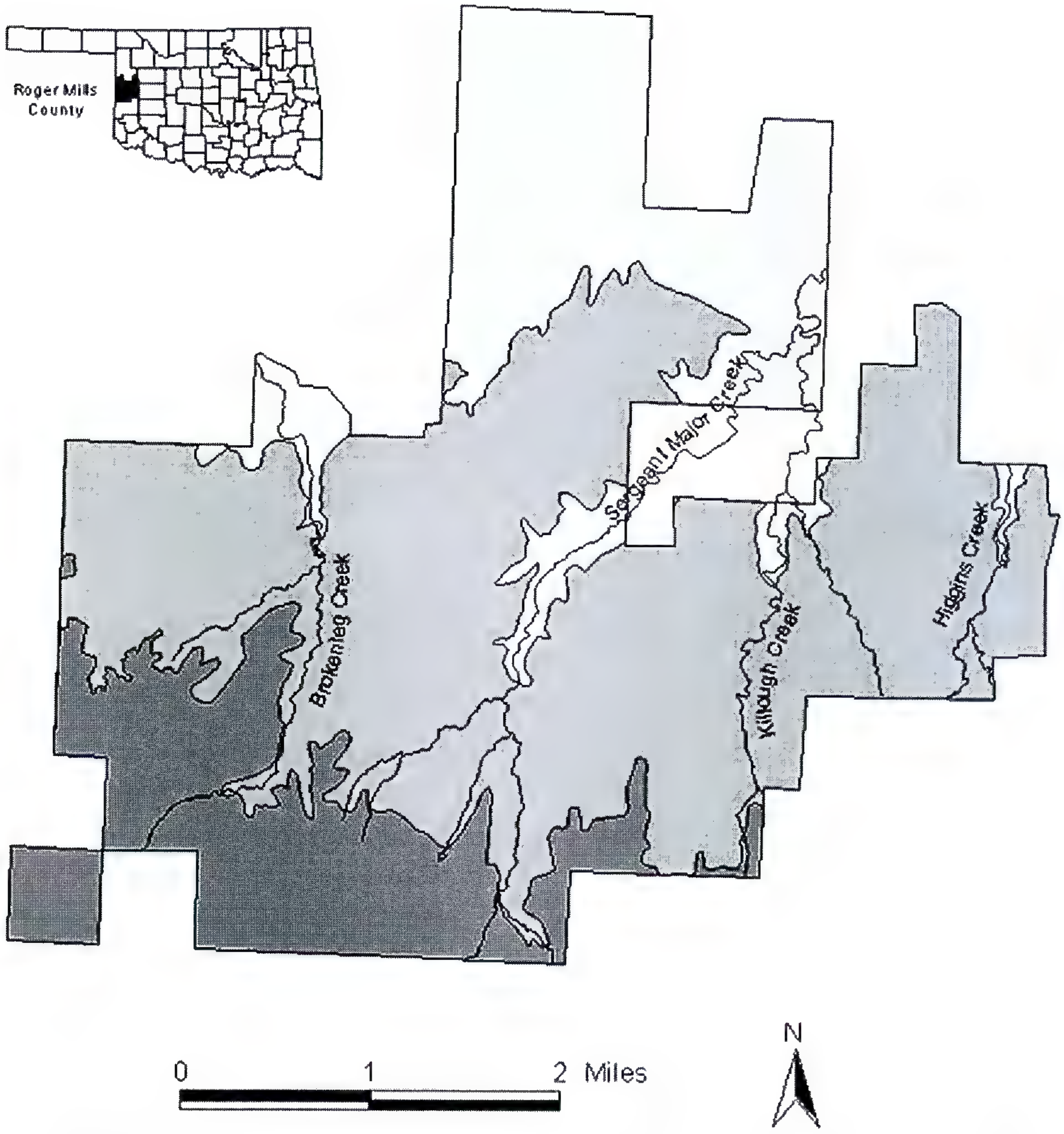


FIG. 1. The Thurmond Ranch, Roger Mills County, Oklahoma. **Dark gray** = Ogallala Formation, **gray** = Doxey Shale Formation, **light gray** = Cloud Chief Formation.

Survey 2002). More than 75% of the annual precipitation occurs from April through October, and precipitation is most abundant in May (12 cm) and least abundant in January (2 cm). Average annual temperature at Elk City is 15.8° C. Average January temperature is 2.3° C and average July temperature is 27.7° C. The average frost-free growing season is approximately 208 days (Curry 1970).

The ranch straddles a major geological and ecological boundary—the eastern outcrop edge of the Ogallala Formation, referred to here as the Ogallala ecotone. Three major geological formations occur on the Dempsey Divide on the ranch: the Tertiary period Ogallala Formation, and the Permian period Doxey Shale and Cloud Chief formations (Fig. 1). Thurmond et al. (2002) discuss the

geomorphology of each formation, but because differences among them have profoundly affected the local topography, vegetation, and history of human use, a brief summary follows.

The Ogallala Formation comprises late Miocene- and Pliocene-age, alluvial outwash from the Rocky Mountains. Its coarse sediments were deposited across the western Great Plains by braided streams, many of which arose in the Rocky Mountains where they were fed by episodically intense rainfall (Frye & Leonard 1957; Gustavson & Finley 1985; Gutentag et al. 1984; Reeves & Reeves 1996; Ryder 1996; Seni 1980). Much of the lower Ogallala is extremely sandy. It forms a gently rolling landscape atop the Dempsey Divide and was significantly reworked by wind into dunes and deflation basins in the late Pleistocene (Thurmond & Wyckoff 1998).

The Doxey Shale comprises discontinuous claystone and sandy siltstone beds deposited during the Permian period on a tropical coastal floodplain. It generally is dense, fine textured, and resists downward percolation of groundwater. Consequently, many streams leading off the Ogallala Formation are spring fed at the Ogallala-Doxey Shale contact. Seeps and small springs do occur in the Doxey Shale outcrop, but only in particularly wet years. The Doxey Shale is fairly resistant to erosion, and its outcrop is typified by deep canyonlands.

Beneath the Doxey Shale is the Permian Cloud Chief Formation (Carr & Bergman 1976), which comprises soft, finely laminated sandstone with thin layers of interbedded gypsum. The Cloud Chief erodes more evenly and readily than does the Doxey Shale, yielding a more gently rolling topography. Upon transition from the Doxey Shale to the Cloud Chief, slope gradients decrease dramatically and stream valleys broaden.

Geologically, the Ogallala ecotone is an unstable and dynamic landscape. Deposition of the Ogallala Formation ended in the Late Pliocene, and the eastern edge of the formation has been eroding episodically westward since. The outcrop edge on the ranch is estimated to have retreated more than 1.5 km since the end of the last glaciation, 15,000–10,000 years B.P. (Thurmond & Wyckoff 2001).

The complex geology and intensely dissected terrain on the north side of the Dempsey Divide have yielded a patchwork of soils. Deep, calcareous, coarse-textured mollisols dominate on the Ogallala and have a much higher effective precipitation than do soils on the Permian outcrops. Extensive exposures of weathering bedrock characterize the Doxey Shale, except where gully fills have facilitated the development of isolated alfisols, inceptisols, and mollisols. These same soil types achieve greater expression on the more gentle landscape of the Cloud Chief outcrop, but evaporites discourage plant growth in many eroded areas (Thurmond et al. 2002).

The geological and topographical setting of the Dempsey Divide has pro-

vided unusual environmental conditions for the development of the region's biota. Diverse terrestrial, palustrine, and riverine natural communities interdigitate along the Ogallala ecotone, and humans have long taken advantage of the natural resources available in this environment. A remarkable concentration of hunter-gatherer campsites is associated with the ecotone, and it has been inferred that these sites were situated to make most efficient use of the diverse floral and faunal communities along this boundary (Thurmond 1990, 1991b).

Human occupation of the Ogallala ecotone on the Dempsey Divide has not been continuous over time. Prehistoric habitation was most intense during the particularly wet periods of the 10th and 2nd millennia before present (Thurmond & Wyckoff 2001). Settlement by Euro-Americans began in earnest in the late 1800s. Between the 1890s and the early 1900s, homesteaders exploited the landscape for crop and livestock production. Approximately 17% (630 ha) of the ranch was farmed, and cattle and horses intensively grazed the rest. Homesteaders began to leave around 1915, and the Thurmond family purchased most of the land composing the ranch between 1915 and 1950. The last of the cultivated land was reseeded to grass in the early 1960s, and land use has been limited to low-intensity grazing by cattle since that time. Deep drilling for natural gas has caused localized disturbance since the late 1970s. Erosion on the ranch has been controlled by revegetation efforts and the construction of erosion control structures (Thurmond et al. 2002).

METHODS

Four major collecting trips were made during 2001 by two of the authors (CCF and CAM): 24–25 April, 30 May–1 June, 23–26 July, and 2–4 October. Sites with vegetation representative of the major vegetation alliances on each of the three major geologic formations were visited during each trip. For most species, at least one voucher was collected on each formation on which it was encountered. Information was recorded about the abundance of species and the vegetation alliances in which they occurred. Opportunistic collecting by one of the authors (JPT) and by Hillary Loring of the Kansas Biological Survey netted additional specimens. A complete set of vouchers is deposited in the R.L. McGregor Herbarium (KANU), University of Kansas. Duplicate specimens for many collections are deposited in the Robert Bebb Herbarium (OKL), University of Oklahoma.

Presence/absence data were recorded in a species × geological formation matrix. These data were used to compare the floras of the formations using Dice's coefficient for 1) all species and 2) native species only. Coefficients were obtained using SPSS 9.0 (SPSS Inc. 1998).

Major vegetation alliances tentatively were identified using observational data. Dominant species, associated species, and habitat data were used to identify alliances following the hierarchical classification of Hoagland (2000).

RESULTS AND DISCUSSION

General Characteristics of the Flora

More than 1,400 numbers (3,100 specimens including duplicates) were collected in the study area. These represent 85 families, 286 genera, and 470 species of vascular plants (Table 1). Four additional species were documented in the study area (Thurmond et al. 2002), but vouchers for these were not verified at KANU so they are excluded from this list. The five most species-rich families are Asteraceae (81, 5 non-native), Poaceae (77, 20 non-native), Fabaceae (44, 3 non-native), Euphorbiaceae (19), and Cyperaceae (17). These five families collectively account for 51% of the species currently known in the study area.

Non-natives compose 10% of all of the species documented. The vast majority of these are Eurasian species introduced accidentally or intentionally since the time of Euro-American settlement. *Campsis radicans*, *Carya illinoinensis*, *Catalpa speciosa*, and *Maclura pomifera*, although native to Oklahoma, likely were introduced intentionally by homesteaders. Native Americans may have introduced three other species (*Acorus calamus*, *Echinochloa muricata*, and *Juglans nigra*) in the study area; Thurmond et al. (2002) discuss these taxa in detail. Among the five largest families in the study area, introduced species are proportionally highest in the Poaceae (26%). Three families (Acoraceae, Bignoniaceae, and Tamaricaceae) and 32 genera are represented by non-native species only. Non-native species dominate one plant community on the ranch: the aquatic *Nasturtium officinale* herbaceous alliance.

Populations of four species tracked by the Oklahoma Natural Heritage Inventory (Oklahoma Natural Heritage Inventory 2001) were discovered during the inventory: *Echinocereus reichenbachii*, *Eriogonum alatum*, *Monarda pectinata*, and *Zinnia grandiflora*. All grow on rocky, mixed-grass prairies on the ranch, except *Monarda pectinata*, which is confined to sand prairies and sandsage shrublands.

Epilobium leptophyllum is reported for the first time in Oklahoma. This herbaceous perennial grows in fens, marshes, and seeps throughout the northern and central Great Plains (Great Plains Flora Association 1991) southward to Meade County, Kansas (Great Plains Flora Association 1977). A small population on a seepy, open slope near the Ogallala-Doxey Shale contact is 180 km south-southeast of the nearest Kansas population (Freeman et al., in press).

The number of species documented on each of the three formations in the study area is summarized in Figure 2. Nearly 900 occurrences (species × formation combinations) were recorded. Despite the fact that all collections were made during a single growing season, these records provide insights into the general floristic patterns in the study area.

Thirty percent of all species (140) were documented on all three formations, but there is a clear floristic difference on either side of the Ogallala ecotone (the

TABLE 1. Numerical summary of the vascular flora of the Ogallala ecotone on the Dempsey Divide.

Group	Families	Genera	Species		
			Native	Non-native	Total
Pteridophytes	2	2	2	0	2
Gymnosperms	1	1	2	0	2
Angiosperms	82	283	418	48	466
Monocots	13	61	89	21	110
Dicots	69	222	329	27	356
Total	85	286	422	48	470

Tertiary/Permian outcrop boundary). Floristic similarity, as estimated by Dice's coefficient (D) using all species, was greater between the Cloud Chief and Doxey Shale formations (D = 0.764) than between the Cloud Chief and Ogallala formations (D = 0.625) or the Doxey Shale and Ogallala formations (D = 0.577). The same calculation using native species only yielded slightly higher coefficients but congruent results (D = 0.785 for Cloud Chief and Doxey Shale, D = 0.626 for Cloud Chief and Ogallala, D = 0.594 for Doxey Shale and Ogallala). Twenty-five percent of all species (119) were found only on the Ogallala. A large majority of these are psammophytes. Mesophytes and hydrophytes account for roughly 25% of the Ogallala-only species. Non-native species are distributed roughly proportionally to the species richness of each of the formations (Fig. 2).

Vegetation Alliances

Nineteen vegetation alliances are recognized, but accurate identification and characterization of all alliances, as well as finer resolution of association-level patterns, must await further studies. Given the dearth of vegetation studies for western Oklahoma (Hoagland 2000), future work likely will be useful in refining the existing state vegetation classification.

Woodland Alliances.—A woodland is defined as an open stand of trees with crowns not usually touching and canopy coverage of 25–60% (Hoagland 2000). Structural diversity often is less than in a forest, and trees usually are taller than 5 m (Lauver et al. 1999). Three woodland alliances were identified on the ranch: the *Sapindus saponaria* woodland alliance, the *Populus deltoides* woodland alliance, and the *Salix nigra* woodland alliance. All three occur along riparian corridors, especially on the lower Doxey Shale and on the Cloud Chief formations. Woodland alliances are best developed along the mainstems of Brokenleg, Plum, and Sergeant Major Creeks, but they also extend up the larger tributaries and occur near springs and seeps at the Ogallala-Doxey Shale contact.

Celtis reticulata, *Juglans microcarpa*, *Juniperus virginiana*, *Robinia pseudoacacia*, *Sideroxylon lanuginosum*, and *Ulmus americana* are common trees in these alliances. *Cornus drummondii*, *Forestiera pubescens*, *Rhus*

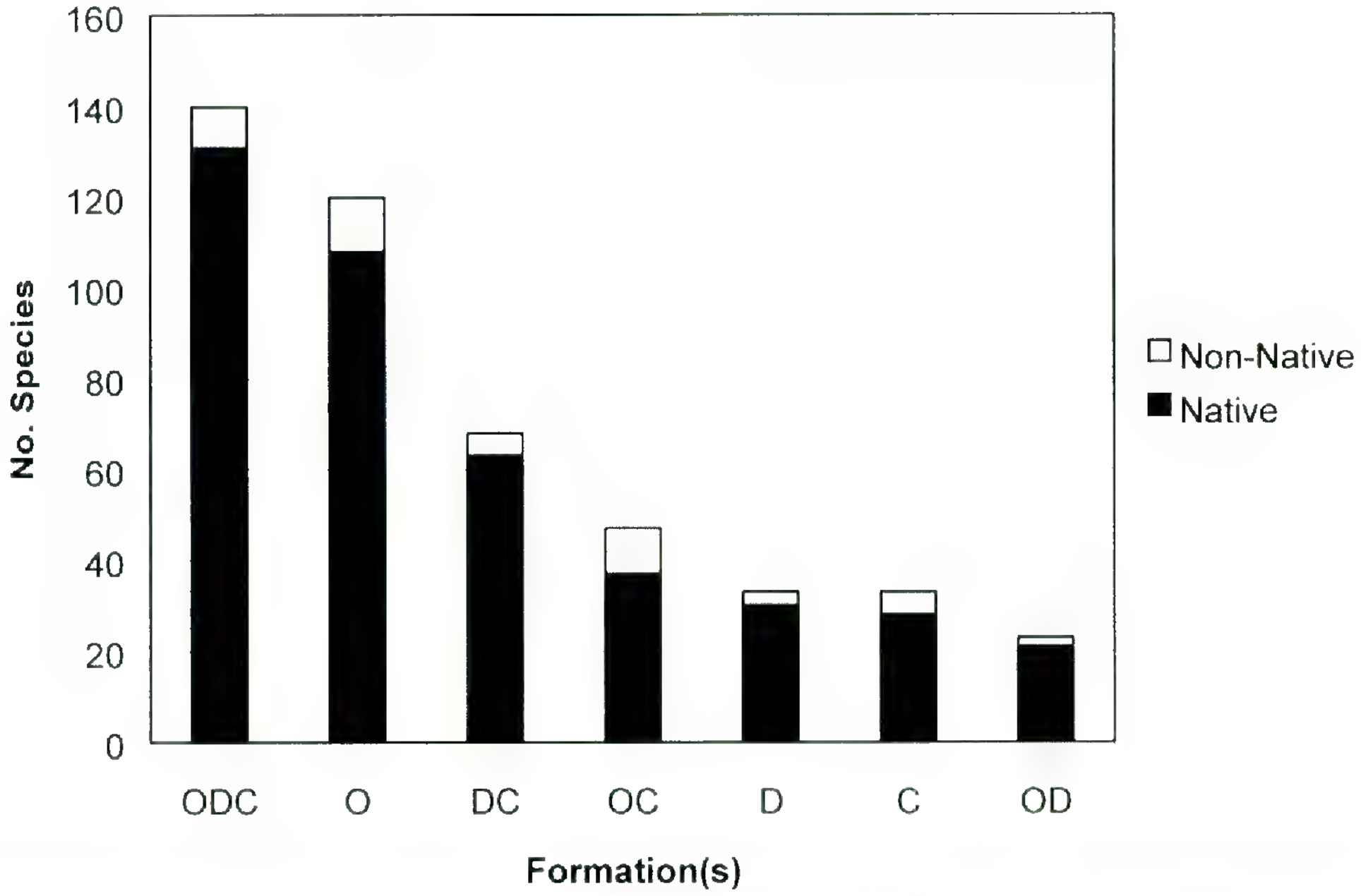


FIG. 2. Species occurrence by formation. **O** = Ogallala; **D** = Doxey Shale; **C** = Cloud Chief.

aromatica, *Rhus glabra*, and *Salix exigua* are typical shrub elements, with *Ampelopsis cordata*, *Parthenocissus quinquefolia*, *P. vitacea*, *Toxicodendron radicans*, and *Vitis acerifolia* the most common woody vines. Representative herbaceous species include *Carex austrina*, *C. bulbostylis*, *C. gravida*, *Chenopodium simplex*, *C. standleyanum*, *Elymus canadensis*, *E. virginicus*, *Galium aparine*, *G. circaezans*, *Geum canadense*, *Phytolacca americana*, and *Sanicula canadensis*. Species restricted to woodland habitats near the Ogallala-Doxey Shale contact are *Bidens bipinnatus*, *Botrychium virginianum*, and *Rubus bushii*.

Shrubland Alliances.—Shrubs or trees 0.5–5 m tall dominate a shrubland, individuals or clumps do not touch or overlap, shrub canopy cover generally is greater than 25%, and tree canopy cover is less than 25% (Hoagland 2000; Lauver et al. 1999). Seven shrubland alliances were identified on the ranch. Some upland sites on the Doxey Shale and Cloud Chief formations support large populations of *Mimosa borealis*, and this likely represents an undescribed, xerophytic, deciduous, shrubland alliance.

The *Quercus havardii* shrubland alliance and the *Artemisia filifolia* shrubland alliance are largely confined to deep dunes and alluvial sands above the Ogallala Formation. *Quercus havardii* and *Artemisia filifolia* are the dominant shrubs, respectively. *Sporobolus cryptandrus* and *Schizachyrium scoparium* are codominant graminoids in both alliances. Characteristic species in both types are *Ambrosia psilostachya*, *Amphiachyris dracunculoides*, *Andropogon hallii*, *Artemisia ludoviciana*, *Bouteloua curtipendula*, *B. hirsuta*, *Calylophus*

serrulatus, *Cenchrus spinifex*, *Chamaesyce glyptosperma*, *Croptilon hookerianum*, *Cyperus lupulinus*, *C. schweinitzii*, *Dalea candida*, *D. enneandra*, *Eriogonum annuum*, *E. longifolium*, *Liatris punctata*, *Machaeranthera pinnatifida*, *Mentzelia nuda*, *Mimosa borealis*, *Paronychia jamesii*, *Plantago patagonica*, *Prionopsis ciliata*, *Rhus aromatica*, *Stenosiphon linifolius*, *Thelesperma megapotamicum*, *Xanthisma texanum*, and *Yucca glauca*.

Two other shrubland alliances, the *Prunus angustifolia* alliance and the *Rhus aromatica* alliance, frequently are found on the Ogallala Formation, but they also occur in sandy, gravelly, or silty sites on Permian substrates. *Schizachyrium scoparium* occurs as a codominant in the former type and is a regular associate in the latter. Other associates include *Andropogon hallii*, *Bouteloua curtipendula*, *Croptilon hookerianum*, *Eriogonum annuum*, *Plantago patagonica*, *Prionopsis ciliata*, *Prunus gracilis*, *Rhus aromatica*, *Toxicodendron radicans*, and *Vitis acerifolia*.

Three shrubland alliances occur along streams and shorelines of ponds and reservoirs: the *Salix exigua* alliance, *Cephalanthus occidentalis* alliance, and *Tamarix chinensis*[= *Tamarix ramosissima*] alliance. Associates in all three types are *Aster subulatus*, *Baccharis salicina*, *Distichlis spicata*, *Panicum virgatum*, *Polygonum lapathifolium*, *Pascopyrum smithii*, *Pluchea odorata*, and *Populus deltoides*.

Herbaceous Alliances.—Herbaceous plants, usually with at least 25% cover, dominate the herbaceous alliances. Trees and shrubs form less that 25% cover (Hoagland 2000; Lauver et al. 1999). Herbaceous alliances, which include grasslands, are the predominant vegetation in the study area. Eight herbaceous alliances were identified on the ranch, five of which are grassland types.

The *Andropogon hallii* herbaceous alliance, called sand prairie, is a tall sod grassland alliance. The best examples occur on deep dune sands atop the Ogallala Formation, with isolated occurrences on well-drained, sandy or gravelly soils on the Permian substrates. *Artemisia filifolia*, *Prunus angustifolia*, *Quercus havardii*, and *Rhus aromatica* are typical shrubs. The sand prairie shares many of the herbaceous associates found in the *Quercus havardii* shrubland alliance and the *Artemisia filifolia* shrubland alliance. Additional associates are *Aristida purpurascens*, *Froelichia floridana*, *F. gracilis*, *Gaura villosa*, *Lechea tenuifolia*, *Oenothera rhombipetala*, *Penstemon buckleyi*, and *Polygonum tenue*.

Medium-tall sod grassland types, called mixed-grass prairies, dominate the northern three-quarters of the ranch on Permian substrates. Three types were identified: the *Bothriochloa laguroides* herbaceous alliance, *Schizachyrium scoparium-Bouteloua curtipendula* herbaceous alliance, and *Bouteloua curtipendula* herbaceous alliance. Additional work is needed to determine the extent and composition of these alliances, which share many species. *Gutierrezia sarothrae* and *Mimosa borealis* are characteristic shrubs. Herbaceous associates include *Allium drummondii*, *Ambrosia psilostachya*,

Ammoselinum popei, *Amphiachyris dracunculoides*, *Aristida purpurea*, *Artemisia ludoviciana*, *Aster ericoides*, *A. falcatus*, *A. fendleri*, *Bothriochloa ischaemum*, *Bouteloua curtipendula*, *B. hirsuta*, *Buchloë dactyloides*, *Callirhoë involucrata*, *Castilleja purpurea*, *Chaetopappa ericoides*, *Chamaesyce fendleri*, *Cirsium ochrocentrum*, *C. undulatum*, *Croton texensis*, *Dalea candida*, *D. enneandra*, *Eriogonum alatum*, *E. longifolium*, *Gaura coccinea*, *Grindelia squarrosa*, *Lesquerella gordonii*, *L. ovalifolia*, *Liatris punctata*, *Linum rigidum*, *Lygodesmia juncea*, *Machaeranthera pinnatifida*, *Penstemon albidus*, *Plantago patagonica*, *Schedonnardus paniculatus*, *Schizachyrium scoparium*, *Sporobolus compositus*, *S. cryptandrus*, *Stenosiphon linifolius*, *Tetraneuris scaposa*, *Thelesperma megapotamicum*, *Vulpia octoflora*, *Xanthisma texanum*, and *Yucca glauca*.

Two other grassland alliances occur along streams, shorelines of ponds and reservoirs, and marshes. Intermittently flooded habitats support the *Pascopyrum smithii* herbaceous alliance. Typical associates include *Aster subulatus*, *Cyperus odoratus*, *Echinochloa crusgalli*, *E. muricata*, *Hordeum jubatum*, *Muhlenbergia asperifolia*, *Phyla lanceolata*, *P. nodiflora*, *Pluchea odorata*, *Polypogon monspeliensis*, and *Schoenoplectus pungens*. Semipermanently flooded areas support the *Scirpus pungens* (misapplied as *Schoenoplectus americanus* in Hoagland [2000] and many earlier floristic works) herbaceous alliance. Associates are *Ammannia coccinea*, *Aster subulatus*, *Distichlis spicata*, *Cyperus odoratus*, *Echinochloa crusgalli*, *E. muricata*, *Eleocharis coloradoensis*, *E. macrostachya*, *E. montevidensis*, *E. rostellata*, *Fuirena simplex*, *Leersia oryzoides*, *Muhlenbergia asperifolia*, *Phalaris caroliniana*, *Poa arida*, *Juncus torreyi*, *Phyla nodiflora*, *Pluchea odorata*, *Potentilla paradoxa*, *Ranunculus cymbalaria*, *R. sceleratus*, *Rumex altissimus*, *Setaria parviflora*, and *Typha domingensis*.

The *Lesquerella* (*gordonii*, *ovalifolia*) herbaceous alliance occurs on rock outcrops and rocky or gravelly slopes on the Doxey Shale and Cloud Chief formations. Generally, perennial forbs contribute greater than 50% of the total herbaceous cover in this alliance. Typical associates include *Artemisia campestris*, *Bouteloua curtipendula*, *B. hirsuta*, *Hedeoma drummondii*, *Hedyotis nigricans*, *Heterotheca stenophylla*, *Krameria lanceolata*, *Oenothera macrocarpa*, *Schizachyrium scoparium*, *Scutellaria resinosa*, and *Tetraneuris scaposa*.

The *Nasturtium officinale* herbaceous alliance is found around springs and along spring runs. It is dominated by hydromorphic, rooted vegetation that grows in permanently flooded environments. Associates are *Eleocharis montevidensis*, *Leersia oryzoides*, *Muhlenbergia asperifolia*, and *Schoenoplectus pungens*. The abundance and persistence of many other species appear to depend on local microhabit conditions.

Disturbed or degraded uplands on Permian formations often are similar to Hoagland's (2000) *Amphiachyris dracunculoides* herbaceous alliance. Char-

acteristic species of this annual grassland alliance are *Ambrosia psilostachya*, *Aristida oligantha*, *A. purpurea*, *Bothriochloa ischaemum*, *B. laguroides*, *Bouteloua curtipendula*, *B. hirsuta*, *Bromus japonicus*, *Chloris verticillata*, *Eragrostis curvula*, *Schizachyrium scoparium*, and *Sporobolus cryptandrus*.

Ruderal Sites.—Natural and semi-natural vegetation alliances typically contain areas in which the native vegetation is disturbed as a result of localized or widespread environmental or biological perturbations. Non-native species often colonize these ruderal sites, and in some cases, aggressive non-natives may spread and severely affect native plant communities. Parts of the ranch were cultivated prior to 1915, but all such areas have since been reseeded to native grasses and forbs. Many non-native species occupy these formerly cultivated sites. Other non-native species are found on the ranch around old farmsteads and newer building sites, along the shoulders of ranch roads, in corrals, and in sites where cattle congregate.

The most frequent non-natives in ruderal sites are *Aegilops cylindrica*, *Bothriochloa ischaemum*, *B. laguroides*, *Bromus catharticus*, *B. japonicus*, *Cynodon dactylon*, *Echinochloa crusgalli*, *Eragrostis curvula*, *Lactuca serriola*, *Medicago minima*, *Melilotus alba*, *M. officinalis*, *Rumex crispus*, *Salsola tragus*, *Setaria viridis*, *Sorghum halepense*, *Taraxacum laevigatum*, and *Tragopogon dubius*.

ANNOTATED CHECKLIST

Family names are arranged alphabetically within three major groups: pteridophytes, gymnosperms, and angiosperms. Genera, species, and infraspecific taxa are arranged alphabetically within each family. Nomenclature for scientific names and common names follows Freeman (2002). Names used in the Atlas of the Flora of the Great Plains (Great Plains Flora Association 1977) and Flora of the Great Plains (Great Plains Flora Association 1991) but synonymized in Freeman (2002) are identified as "A" and "F", respectively. Additional notes clarify nomenclatural issues for some species. An asterisk (*) identifies non-native species as identified by the Great Plains Flora Association (1991) and Freeman (2002).

Relative frequency of each species on the ranch is estimated from the number of populations seen by the authors using a slightly modified version of the scale proposed by Palmer et al. (1995): abundant (**5**) = dominant or codominant in one or more plant alliances; frequent (**4**) = easily seen or found in one or more plant alliances (e.g., mixed-grass prairie or woodland) but not dominant in any plant alliances; occasional (**3**) = widely scattered but not difficult to find in one or more plant alliances; infrequent (**2**) = difficult to find with few individuals or colonies but found in several locations in one or more plant alliances; and rare (**1**) = very difficult to find and limited to one or few populations in one or more plant alliances.

Alliance data for each species are summarized by major habitat types as follows: **w** = woodlands (including riparian woodlands); **s** = sandy complex (including sand prairies, sandsage shrublands, and shinnery oak shrublands); **m** = mixed-grass prairies (including clayey, silty, sandy, gravelly, and rocky mixed-grass prairies, rock outcrops, and rocky slopes); **p** = palustrine communities (including seeps and marshes); **r** = riverine sites (including spring runs and streams); **l** = lacustrine communities (including ponds and reservoirs); and **u** = ruderal sites (including abandoned homesites, roadsides, and well sites).

Geologic formations from which specimens were collected, or in a few cases observed but not collected, are designated for each taxon by the following abbreviations: **O** = Tertiary Ogallala, **D** = Permian Doxey Shale, and **C** = Permian Cloud Chief. Collection numbers for voucher specimens are cited after any synonyms. Abbreviations for collector names are **F** (Craig C. Freeman), **L** (Hillary Loring), **M** (Caleb A. Morse), and **T** (J. Peter Thurmond).

PTERIDOPHYTES

EQUISETACEAE

Equisetum laevigatum A. Braun, Smooth scouring rush, 2; p,r; O. F16890

OPHIOGLOSSACEAE

Botrychium virginianum (L.) Sw., Rattlesnake fern, common grape fern, 1; w,p; O. MF5973

GYMNOSPERMS

CUPRESSACEAE

Juniperus pinchotii Sudw., Pinchot juniper, 1; m; D. F16865, FM17942

Juniperus virginiana L. var. *virginiana*, Eastern redcedar, 3; w,m; O,D,C. F16935, FM17689, FM17811, MF6386

ANGIOSPERMS

ACANTHACEAE

Ruellia humilis Nutt., Fringe-leaf wild-petunia, 2; s; O. MF6061

ACORACEAE

**Acorus calamus* L., European sweetflag, 1; p,r; O. MF5982

AGAVACEAE

Yucca glauca Nutt., Small soapweed, 4; s,m; O,D,C. MF6186, MF6406, MF6421, MF6435, MF6501

ALISMATACEAE

Echinodorus berteroi (Spreng.) Fassett, Upright burhead, 2; l; D,C. [*E. rostratus* (Nutt.) Engelm. ex A. Gray – A, F] FM17798, FM17881

AMARANTHACEAE

Amaranthus albus L., Tumbleweed amaranth, 2; l,u; O,D,C. FM17821, FM17930, FM18404

Amaranthus arenicola I.M. Johnst., Sandhill pigweed, 1; s; O. FM17698

Amaranthus blitoides S. Watson, Prostrate pigweed, 4; u; O,D,C. [*A. graecizans* L. – A, F] FM17603, FM17905, FM18339, MF6014, MF6170, MF6210

Amaranthus palmeri S. Watson, Palmer's pigweed, 1; u; O,D. L2001-51, MF6462

Amaranthus retroflexus L., Rough pigweed, Red root pigweed, 1; u; O,D,C. FM17929, MF6392, MF6463

Froelichia floridana (Nutt.) Moq., Field snake-cotton, 2; s; O. FM17714

Froelichia gracilis (Hook.) Moq., Slender snake-cotton, 2; s,m; O. FM17657, MF6487

ANACARDIACEAE

Rhus aromatica Aiton var. *pilosissima* (Engelm.) Shinners, Fragrant sumac, 2; w,m; C. FM17521

Rhus aromatica Aiton var. *serotina* (Greene) Rehder, Fragrant sumac, 3; w,m; O,D,C. F16875, FM17662, MF5950, MF6277

Rhus aromatica Aiton var. *trilobata* (Nutt.) A. Gray, Fragrant sumac, 1; m; D. MF6137

Rhus glabra L., Smooth sumac, 3; w,s,m; O,D,C. FM17590, L2001-23, MF5945, MF6136, MF6278

Toxicodendron radicans (L.) Kuntze subsp.

negundo (Greene) Gillis, Poison-ivy, 3; w,s,m; O,D,C. F16899, FM17769, MF6397

Toxicodendron rydbergii (Small ex Rydb.) Greene, Rydberg's poison-ivy, Western poison-ivy, 1; w,s; O. FM17663

APIACEAE

Ammoselinum popei Torr. & A. Gray, Plains sand-parsley, 4; m; D,C. F16863, F16901, F16921, MF6258

Cymopterus macrorhizus Buckley, Big-root spring-parsley, 2; m; D,C. F16850, F16930, F16945

Lomatium foeniculaceum (Nutt.) J.M. Coult. & Rose var. *daucifolium* (Nutt.) Cronquist, Fennel-leaf desert-parsley, 2; m; D,C. F16849, F16951

Sanicula canadensis L. var. *canadensis*, Canadian sanicle, 3; w; D,C. FM17869, MF5934, MF6366

Spermolepis inermis (Nutt.ex DC.) Mathias & Constance, Spreading scaleseed, Western scaleseed, 2; s; O,D. MF6004, MF6124, MF6473

* *Torilis arvensis* (Huds.) Link, Field hedge parsley, 2; w,u; D,C. MF6352, MF6364

APOCYNACEAE

Apocynum cannabinum L., Hemp dogbane, Prairie dogbane, 3; m,p; O,D,C. FM17735, MF5955, MF6133, MF6275

ASCLEPIADACEAE

Asclepias asperula (Decne.) Woodson subsp. *capricornu* (Woodson) Woodson, Antelope horn milkweed, 3; s,m; O,D,C. [*A. asperula* (Decne.) Woodson var. *decumbens* (Nutt.) Shinners – A, F] MF6050, MF6103, MF6222

Asclepias engelmanniana Woodson, Engelmann's milkweed, 3; s,m; O,D,C. FM17541, FM17666, FM17779, FM18396, FM18483, FM18484, MF6140, MF6412

Asclepias latifolia (Torr.) Raf., Broad-leaf milkweed, 3; s,m; O,D. FM17906, FM18321

Asclepias stenophylla A. Gray, Narrow-leaf milkweed, 1; s; O. MF6066

Asclepias tuberosa L. subsp. *interior* Woodson, Butterfly milkweed, 2; s; O. MF6008, MF6441

Asclepias viridiflora Raf., Green milkweed, 3; s,m; O,D,C. FM17593, FM17702, FM17907, MF6002, MF6144, MF6285, MF6449

Asclepias viridis Walter, Spider milkweed, 1; s; O. FM17672

ASTERACEAE

Ambrosia psilostachya DC., Western ragweed, 4; s,m; O,D,C. FM17604, FM17775, FM17873, FM18264, FM18299, FM18393

Ambrosia trifida L., Giant ragweed, 1; w,u; O,C. FM18325, FM18472

Amphiachyris dracunculoides (DC.) Nutt., Common broomweed, 5; s,m; O,D,C. [*Gutierrezia dracunculoides* (DC.) S.F. Blake – A, F] FM17904, FM17934, FM18263, FM18309, FM18409

Aphanostephus skirrhobasis (DC.) Trel. var. *skirrhobasis*, Parasol lazy-daisy, 2; s; O. MF6026, MF6439

Artemisia campestris L. subsp. *caudata* (Michx.) H.M. Hall & Clem., Western sagewort, 2; s,m; O. FM18307

Artemisia dracunculus L., Silky wormwort, Tarragon, 2; m; D. FM18395, FM18420, L2001 118

Artemisia filifolia Torr., Sand sagewort, 5; s,m; O,D,C. FM17626, FM17836, FM18340, FM18475

Artemisia ludoviciana Nutt. var. *ludoviciana*, Louisiana sagewort, 4; s,m; O,D,C. FM 17522, FM17899, FM17926, FM18265, FM18394, FM18459

Aster ericoides L. subsp. *ericoides* var. *ericoides*, Heath aster, White aster, 3; s,m; O,D,C. FM18266, FM18268, FM18305, FM18408

Aster falcatus Lindl. subsp. *commutatus* (Torr. & A. Gray) A.G. Jones, Western heath aster, 3; m,p; O,D,C. FM18362, FM18416, FM18457

Aster fendleri A. Gray, Fendler's aster, 3; m; D,C. FM18267, FM18407, FM18417, L2001-16

Aster oblongifolius Nutt., Aromatic aster, 2; s,m; O,D. FM18306b, FM18363, FM18418

Aster patens Aiton var. *patentissimus* (Lindl. ex DC.) Torr. & A. Gray, Sky-drop aster, 2; s; O. FM17576, FM18306a

Aster subulatus Michx. var. *ligulatus* Shinners, Saltmarsh aster, 4; p,r,l; O,D,C. FM17767, FM18361, FM18428, FM18449

Baccharis salicina Torr. & A. Gray, Willow baccharis, 3; p,r,l; O,D,C. FM17639, FM17721, FM17761, FM17841, FM17868

Berlandiera betonicifolia (Hook.) Small, Betony-leaf berlandiera, 2; s; O. [*B. texana* DC. – A, F] MF6077, MF6431

Bidens bipinnatus L., Spanish needles, 1; w; O. FM17679

Bidens comosus (A. Gray) Wiegand, Leafy-bract beggar-ticks, 1; l; C. FM18436

Bidens frondosus L., Devil's beggar-ticks, 2; w,l; C. FM18329, FM18435

Brickellia eupatorioides (L.) Shinners var. *corymbulosa* (Torr. & A. Gray) Shinners, Eastern brickellbush, 2; s,m; O,C. [*Kuhnia eupatorioides* L. var. *corymbulosa* Torr. & A. Gray – A, F] FM18303

Chaetopappa ericoides (Torr.) G. Nesom, Heath least daisy, 3; m; D,C. [*Leucelene ericoides* (Torr.) Greene – A, F] F16826, F16866, MF6148, MF6242

Cirsium ochrocentrum A. Gray, Yellow-spine thistle, 3; m; D,C. FM17851, MF6338, MF6360

Cirsium undulatum (Nutt.) Spreng., Wavy-leaf thistle, 3; s,m; O,D,C. FM17562, FM17667, FM17837

Conyza canadensis (L.) Cronquist, Tall horseweed, Canadian horseweed, 3; s,u; O,D,C. FM17581, FM17939, FM18424

Croptilon hookerianum (Torr. & A. Gray) House var. *validum* (Rydb.) E.B. Sm., Slender goldenweed, 4; s,m; O. [*Haplopappus validus* (Rydb.) Cory – A, F] FM17599, FM17713, FM17920, FM18355

Cyclachaena xanthifolia (Nutt.) Fresen., Rag sumpweed, Bur-weed marshelder, 1; w,u; O. [*Iva xanthifolia* Nutt. – A, F] FM18323

Dyssodia papposa (Vent.) Hitchc., Prairie fetid-marigold, 2; m,u; D,C. FM17938, FM18385

Echinacea angustifolia DC. var. *angustifolia*, Narrow-leaf coneflower, 2; m,s; O,C. FM17528, FM17611, MF6065

Eclipta prostrata (L.) L., Yerba de tajo, 2; r,l; O,D,C. FM17588, FM17754, FM18439

Engelmannia peristenia (Nutt. ex Rydb.) Goodman & C.A. Lawson, Engelmann daisy, 3; m,s; O,D,C. [*E. pinnatifida* Nutt. – A, F] FM17664, MF6149, MF6272

Erigeron modestus A. Gray, Plains fleabane, 2; m; D,C. F16875, F16932, FM18399, MF6131, MF6316, MF6346

Erigeron strigosus Muhl. ex Willd., Daisy fleabane, 3; m,s; O,D,C. MF6068, MF6130, MF6302

Eupatorium perfoliatum L., Clasping leaf joe-pye weed, Boneset, 2; p,r; O. FM17719, FM18328

Euthamia gymnospermoides Greene, Sticky euthamia, 1; r; O. [*Solidago graminifolia* (L.) Salisb. var. *gymnospermoides* (Greene) Croat – A; *S. graminifolia* (L.) Salisb. var. *media* (Greene) S.K. Harris – A] FM18349

Evax prolifera Nutt. ex DC., Big-head rabbit-tobacco, 2; m,s; O,D,C. F16898, FM17755, MF6238, MF6354, MF6470

Gaillardia pulchella Foug. var. *pulchella*, Indian blanket-flower, Rose-ring blanket-flower, 3; m; O,D,C. MF6027, MF6094, MF6212

Gaillardia suavis (A. Gray & Engelm.) Britton & Rusby, Rayless blanket-flower, 2; m; D,C. MF6127, MF6232

Grindelia squarrosa (Pursh) Dunal var. *nuda* (A.W. Wood) A. Gray, Curly-top gumweed, 3; s,m,u; O,D,C. FM17921, FM18271, FM18312

Gutierrezia sarothrae (Pursh) Britton & Rusby, Broom snakeweed, 4; s,m; O,D,C. FM17894, FM18274, FM18301, FM18405, L2001-20

Helianthus annuus L., Common sunflower, 2; u; O,D,C. FM17693, FM17772, FM18380, FM18482, L2001-101

Helianthus maximilianii Schrad., Maximilian's sunflower, 1; w; C. Ts.n.

Helianthus petiolaris Nutt. subsp. *petiolaris*, Plains sunflower, 2; s,m; O,C. FM17586, FM18308, L2001-79, MF6028

Helianthus tuberosus L., Jerusalem-artichoke sunflower, 1; p, O,C. L2001-56

Heterotheca latifolia Buckley var. *macgregoris* B. Wagenkn., Broad-leaf golden-aster, 3; s,m; O,D,C. FM17606, FM17918, FM18304, L2001-76

Heterotheca stenophylla (A. Gray) Shinners var. *angustifolia* (Rydb.) Semple, Narrow-leaf golden-aster, 3; m; O,D,C. [*Chrysopsis villosa* (Pursh) Nutt. ex DC. var. *angustifolia* (Rydb.) Cronquist – A, F] FM17530, FM17807, FM18310

Heterotheca stenophylla (A. Gray) Shinners var. *stenophylla*, Narrow-leaf golden-aster, 2; s,m; O,D. [*Chrysopsis stenophylla* (A. Gray) Shinners – A, F] FM17838, FM17919, MF6486

Hymenopappus tenuifolius Pursh, Chalk-hill woolly-white, 3; s,m; O,D,C. FM17629, FM17898, MF6011, MF6122, MF6206, MF6419, MF6442

Lactuca ludoviciana (Nutt.) Ridd., Western lettuce, Louisiana lettuce, 1; w; C. MF6378

**Lactuca serriola* L., Prickly lettuce, 2; u; O,D. FM17632, FM17791, FM17796

Liatris punctata Hook., Western dotted

gayfeather, 4; s,m; O,D,C. FM17893, FM18275, FM18311, FM18411, L2001-14

Liatris squarrosa (L.) Michx. var. *glabrata* (Rydb.) F.C. Gates, Plains gayfeather, 2; s; O. [*L. glabrata* Rydb. – A] FM17580

Lindheimera texana A. Gray & Engelm., Texas-star, 1; m; C. MF6314

Lygodesmia juncea (Pursh) D. Don ex Hook., Rush skeleton weed, 3; m; C. FM18270, FM18481, MF6292

Machaeranthera pinnatifida (Hook.) Shinners var. *glaberrima* (Rydb.) B.L. Turner & R.L. Hartm., Cut-leaf tansy-aster, 4; s,m; O,D,C. [*Haplopappus spinulosus* (Pursh) DC. subsp. *glaberrimus* (Rydb.) H.M. Hall – F] FM17834, MF6071, MF6090, MF6234

Machaeranthera pinnatifida (Hook.) Shinners var. *pinnatifida*, Cut-leaf tansy-aster, 2; m; D,C. [*Haplopappus spinulosus* (Pursh) DC. subsp. *australis* (Greene) H.M. Hall – F; *H. spinulosus* (Pursh) DC. subsp. *cotula* (Small) H.M. Hall – F; *H. spinulosus* (Pursh) DC. subsp. *spinulosus* – A, F] MF6085, MF6207

Melampodium leucanthum Torr. & A. Gray, Plains blackfoot, 3; m; D,C. F16949, FM18270, FM18392, MF6099, MF6260, MF6409

**Onopordum acanthium* L., Scotch thistle, 1; w,u; D,C. MF6330

Packera plattensis (Nutt.) W.A. Weber & Á. Löve, Prairie ragwort, 3; m; O,D,C. [*Senecio plattensis* Nutt. – A, F] F16845

Plectocephalus americanus (Nutt.) D. Don, American knapweed, Basket-flower, 3; m; D,C. [*Centaurea americana* Nutt – A, F] FM17553, FM17849, FM17936, MF6146, MF6291

Pluchea odorata (L.) Cass., Purple marsh-fleabane, 4; r,l; O,D,C. [*P. purpurascens* (Sw.) DC. – A] FM17638, FM17876, FM18365, FM18448, L2001-29

Prionopsis ciliata (Nutt.) Nutt., Wax-goldenweed, 4; s; O,C. [*Haplopappus ciliatus* (Nutt.) DC. – A, F] FM17718, FM18272, FM18298

Pseudognaphalium obtusifolium (L.) Hilliard & B.L. Burtt, Fragrant false-cudweed, 1; u; O. [*Gnaphalium obtusifolium* L. – A, F] FM18343

Psilostrophe tagetina (Nutt.) Greene var. *cerifera* (A. Nelson) B.L. Turner, Marigold paper-flower, 1; m; C. [*P. villosa* Rydb. – A, F] MF6337

Pyrrhopappus grandiflorus (Nutt.) Nutt., Tuberous false-dandelion, 2; s,m; O,D,C. F16848, MF6037, MF6107, MF6195

Ratibida columnifera (Nutt.) Wooton & Standl., Upright prairie-coneflower, 2; s,m; O,D,C. MF6036, MF6125, MF6263

Senecio riddellii Torr. & A. Gray, Riddell's grounsel, 3; s,m; O,D. FM18302, FM18415

Solidago altiplanities C.E.S. Taylor & R.J. Taylor, High-plains goldenrod, 3; m; O,D,C. FM17557, FM18273, FM18300, FM18403, FM18419

Solidago canadensis L. var. *scabra* (Muhl. ex Willd.) Torr. & A. Gray, Canadian goldenrod, 2; w,p,r; O,C. FM17734, FM18327, FM18446

Solidago gigantea Aiton, Late goldenrod, November goldenrod, 1; w,p,r; O. FM18346

Solidago missouriensis Nutt., Missouri goldenrod, Prairie goldenrod, 2; s,m; O,C. FM17709, FM17877, FM18462, Ts.n.

Solidago petiolaris Aiton var. *petiolaris*, Downy goldenrod, 1; s,m; O,D. FM18372, FM18402

**Sonchus asper* (L.) Hill, Prickly sow-thistle, 2; u; O,C. MF5974, MF6297

**Taraxacum laevigatum* (Willd.) DC., Red-seed dandelion, 2; m,u; O,C. F16913, MF6283

Tetraneuris scaposa (DC.) Greene var. *scaposa*, Naked-stem tetraneuris, 4; m; D,C. [*Hymenoxys scaposa* (DC.) K.L. Parker var. *glabra* (Nutt.) K.L. Parker – A, F; *H. scaposa* (DC.) K.L. Parker var. *scaposa* – A, F] F16825, F16876, F16952, MF6231, MF6418, MF6490

Thelesperma filifolium (Hook.) A. Gray var. *intermedium* (Rydb.) Shinners, Thread-leaf greenthread, 1; m; D. MF6120

Thelesperma megapotamicum (Spreng.) Kuntze, Rio Grande greenthread, 4; s,m; O,D,C. FM17835, MF6074, MF6139, MF6233, MF6417

**Tragopogon dubius* Scop., Western salsify, 2; m,u; O,C. MF6080, MF6267

Verbesina encelioides (Cav.) Benth. & Hook.f. ex A. Gray subsp. *encelioides*, Golden crownbeard, 1; w,u; O. FM18324

Verbesina encelioides (Cav.) Benth. & Hook.f. ex A. Gray subsp. *exauriculata* (B.L. Rob. & Greenm.) J.R. Coleman, Golden crownbeard, 2; u; D. FM18386

Vernonia baldwinii Torr. subsp. *interior* (Small) W.Z. Faust, Western ironweed, 3; s,m; O,D,C. FM17547, FM17585, FM17762, FM17888, FM18421

Xanthisma texanum DC. subsp. *drummondii* (Torr. & A. Gray) Semple, Sleepy daisy, 4; s,m; O,D,C. [*X. texanum* DC. var. *drummondii* (Torr. & A. Gray) A. Gray – A] FM17615, FM17917, FM18313, MF6044, MF6350, MF6451

Xanthium strumarium L., Common cocklebur, 3; I; O,D,C. FM17803, FM18276, FM18377

Zinnia grandiflora Nutt., Rocky Mountain zinnia, 2; m; D,C. MF6095, MF6336, MF6408

BIGNONICACEAE

**Campsis radicans* (L.) Seem., Common trumpet-creeper, Trumpetvine, 1; w,u; O. FM18335

**Catalpa speciosa* Warder, Northern catalpa, Catawba-tree, 2; w,u; O. FM18336, MF5986

BORAGINACEAE

Lappula redowskii (Hornem.) Greene, Flat-spine stickseed, 3; s,m; O,D,C. F16853, F16922, MF5940, MF6293

Lappula texana (Scheele) Britton, Cup-seed stick-seed, 2; s,m; D,C. F16927, F16940

Lithospermum caroliniense (Walter ex J.F. Gmel.) MacMill., Carolina gromwell, Carolina puccoon, 1; s; O. MF6069

Lithospermum incisum Lehm., Plains gromwell, 3; s,m; O,D,C. F16878, F16944, MF6003, MF6154, MF6254, MF6469

BRASSICACEAE

**Camelina microcarpa* Andrz. ex DC., Little-pod false flax, 1; u; C. MF6294, MF6494

**Capsella bursa pastoris* (L.) Medik., Common shepherd's-purse, 2; u; O,D,C. F16838

Descurainia pinnata (Walter) Britton subsp. *halictorum* (Cockerell) Detling, Pinnate tansy-mustard, 2; m,u; O,C. F16880

Dimorphocarpa candicans (Raf.) Rollins, Palmer's spectacle-pod, 1; s; O. [*D. palmeri* (Payson) Rollins – F; *Dithyrea wislizenii* Engelm. var. *palmeri* Payson A] FM17654, MF6424

Draba reptans (Lam.) Fernald, White whitlow-wort, 2; m; O,D,C. F16832

Erysimum asperum (Nutt.) DC., Plains wallflower, 1; m; C. F16948

Lepidium densiflorum Schrad., Prairie pepper-grass, 2; m,u; O,D. F16835, MF6006

Lepidium oblongum Small, Oblong pepper-grass, 2; m,u; D,C. F16836, MF6257

**Nasturtium officinale* R. Br., Common watercress, 1; r; O. F16892, MF5970

Physaria gordonii (A. Gray) O'Kane & Al-Shehbaz, Gordon's bladderpod, 4; m; D,C. [*Lesquerella gordonii* (A. Gray) S. Watson – A, F] F16856, MF6255

Physaria ovalifolia (Rydb.) O'Kane & Al-Shehbaz subsp. *ovalifolia*, Oval-leaf bladderpod, 4; m; O,D,C. [*Lesquerella ovalifolia* Rydb. subsp. *ovalifolia* – A, F] F16847, F16950, MF6404, MF6488

CACTACEAE

Coryphantha vivipara (Nutt.) Britton & Rose var. *vivipara*, Pin-cushion coryphantha, 2; s,m; O,D,C. FM18322, MF6118, MF6331, MF6361

Cylindropuntia imbricata (Haw.) F.M. Knuth var. *imbricata*, Tree cholla, 1; m; C. [*Opuntia imbricata* (Haw.) DC. var. *imbricata* – A, F] FM18485

Echinocereus reichenbachii (Terscheck ex Walp.) F. Haage var. *reichenbachii*, Lace hedgehog cactus, 2; m; D,C. FM17559, MF6192, MF6413

Opuntia macrorhiza Engelm. var. *macrorhiza*, Big-root pricklypear, 3; s,m; O,D,C. FM17560, MF6056, MF6332, MF6362, MF6436

Opuntia phaeacantha Engelm. var. *major* Engelm., New Mexico pricklypear, 1; m; D. FM17852

CAMPANULACEAE

Lobelia cardinalis L., Cardinal-flower, 1; p; O. L2001-61

Triodanis holzingeri McVaugh, Holzinger's Venus'-looking glass, 2; s; O. MF6046, MF6446

Triodanis leptocarpa (Nutt.) Nieuwl., Slender-fruit Venus'-looking-glass, 3; m; D,C. MF6119, MF6235

CAPPARACEAE

Polanisia dodecandra (L.) DC. subsp. *trachysperma* (Torr. & A. Gray) H.H. Iltis, Rough-seed clammyweed, 2; s,m; D,C. MF6298, MF6407

Polanisia jamesii (Torr. & A. Gray) H.H. Iltis, James' clammyweed, Cristatella, 2; s,m; O. [*Cristatella jamesii* Torr. & A. Gray – A] FM17653, FM18282, MF6073, MF6189

CARYOPHYLLACEAE

Loeflingia squarrosa Nutt. subsp. *texana* (Hook.) Barneby & Twisselm., Spreading loeflingia, 1; s; O. MF6062

Paronychia jamesii Torr. & A. Gray, James' nailwort, 4; s,m; O,D,C. FM17525, FM17597, MF6030, MF6110, MF6268, MF6478

Silene antirrhina L., Sleepy catchfly, 3; s,m; O,D,C. F16829, MF6033, MF6161, MF6305, MF6447
**Stellaria pallida* (Dumort.) Crép., Pale chickweed, 1; u; C. F16911

CELASTRACEAE

Celastrus scandens L., American bittersweet, 1; w; C. MF6379

CHENOPODIACEAE

Chenopodium berlandieri Moq. var. *zschackii* (Murray) Murray ex Asch., Pit-seed goosefoot, 3; m,u; O,D. FM17904, FM17931, FM18341, FM18382
**Chenopodium glaucum* L., Oak-leaf goosefoot, 1; l; C. FM18444
Chenopodium missouriense Aellen, Missouri goosefoot, 1; u; C. FM18466
Chenopodium pratericola Rydb., Field goosefoot, 3; s,m; O,D. FM17578, FM17658, FM17776, MF6015, MF6428
Chenopodium simplex (Torr.) Raf., Maple-leaf goosefoot, 2; w; O. [*C. gigantospermum* Aellen – F; *C. hybridum* L. – A] FM17728, FM18332
Chenopodium standleyanum Aellen, Standley's goosefoot, 3; w; O,D,C. FM17682, FM17727, FM17817, FM18333, FM18412, FM18474
Cycloloma atriplicifolium (Spreng.) J.M. Coult., Tumble ringwing, 2; s; O. FM17616, FM18350, MF6013
**Kochia scoparia* (L.) Schrad., Broom kochia, 1; u; C. FM18465
Monolepis nuttalliana (Schult.) Greene, Nuttall's poverty-weed, 3; m,u; D,C. F16908, F16938, MF6200
**Salsola tragus* L., Common Russian-thistle, 3; u; O,D,C. [*S. iberica* Sennen & Pau – A, F] FM17842, FM17940, FM18373

CISTACEAE

Lechea tenuifolia Michx., Narrow-leaf pinweed, 2; s; O. FM17592, FM18315, MF6064

COMMELINACEAE

Commelina erecta L. var. *angustifolia* (Michx.) Fernald, Erect dayflower, 3; s; O. MF5990, MF6024, MF6482
Tradescantia occidentalis (Britton) Smyth & L. Smyth var. *occidentalis*, Western spiderwort, Prairie spiderwort, 3; s,m; O,D,C. MF6029, MF6176, MF6230, MF6444

CONVOLVULACEAE

Convolvulus equitans Benth., Gray bindweed, 1; m; C. MF6199
Evolvulus nuttallianus Schult., Nuttall's evolvulus, 2; m; D,C. FM17529, MF6045, MF6108, MF6199, MF6228
Ipomoea leptophylla Torr., Bush morning-glory, 1; s,m; D. MF6414

CORNACEAE

Cornus drummondii C.A. Mey., Rough-leaf dogwood, 4; w,m; O,D,C. FM17519, FM17661, FM17814, MF5949, MF6123, MF6318

CUCURBITACEAE

Cucurbita foetidissima Kunth, Buffalo gourd, 3; s,m; O,D,C. MF6327, MF6420, MF6461

CUSCUTACEAE

Cuscuta cuspidata Engelm., Cusp dodder, 2; s,m; O,D,C. FM17656, FM18319, L2001-36, L2001-77

CYPERACEAE

Carex austrina Mack., Southern sedge, 2; w,s; O,C. MF6082, MF6395
Carex bulbostylis Mack., Thick-style sedge, 2; w; O,C. [*C. amphibola* Steud. var. *globosa* (L.H. Bailey) L.H. Bailey – Taylor and Taylor (1994)] MF5997, MF6370
Carex gravida L.H. Bailey, Heavy sedge, 3; w,l; O,D,C. F16870, F16887, F16914, MF5943, MF6224, MF6300, MF6358, MF6359, MF6375
Carex pellita Muhl. ex Willd., Woolly sedge, 1; p,r,l; C. [*C. lanuginosa* Michx. – A, F] FM18463
Cyperus acuminatus Torr. & Hook., Tape-leaf flat-sedge, 1; l; O. FM17646
Cyperus lupulinus (Spreng.) Marcks subsp. *lupulinus*, Slender-stem flat-sedge, 2; s,m; O. FM18364, MF5998
Cyperus ×mesochorus Geise, Intermediate flat-sedge, 2; s,m; O. FM17647, MF5599
Cyperus odoratus L., Slender flat-sedge, Rusty flat-sedge, 3; l; O,D,C. FM17640, FM17748, FM17933, F18379, FM18437
Cyperus schweinitzii Torr., Schweinitz's flat-sedge, 2; s,m; O. MF6025, MF6443
Eleocharis coloradoensis (Britton) Gilly, Colorado spike-rush, 4; l; D,C. FM17739, FM17843, FM17855, FM18456
Eleocharis erythropoda Steud., Bald spike-rush, 2; l; O,C. FM17579, FM17859

Eleocharis geniculata (L.) Roem. & Schult., Cluster spike-rush, 1; l; C. [*E. caribaea* (Rottb.) S.F. Blake – A, F] FM17879

Eleocharis macrostachya Britton, Large-spike spike-rush, 4; l; O,D,C. [*E. xyridiformis* Fernald & Brackett – A, F] FM17650, MF6153, MF6357

Eleocharis montevidensis Kunth, Sand spike-rush, 4; p,r,l; O,D,C. FM17717, FM17740, FM17858, MF5971, MF6152, MF6373

Eleocharis palustris (L.) Roem. & Schult., Marsh spike-rush, 1; l; D. [*E. smallii* Britton – A, F] FM17741

Eleocharis rostellata (Torr.) Torr., Beaked spike-rush, 2; p,l; O,C. FM17732, FM17861

Fuirena simplex Vahl var. *aristulata* (Torr.) Kral, Western umbrella-grass, 2; p,r,l; O,D,C. FM17678, FM17759, FM17856

Schoenoplectus pungens (Vahl) Palla var. *longispicatus* (Britton) S.G. Sm., Common threesquare twine-bulrush, 4; p,r,l; O,D,C. [*Scirpus americanus* Pers. – misapplied in A and in Taylor and Taylor (1994); *S. pungens* Vahl – F] FM17716, FM17863, MF5987

EBENACEAE

Diospyros virginiana L., Virginia persimmon, 2; w,p; O,C. FM17725, FM17890

ELATINACEAE

Bergia texana (Hook.) Seub. ex Walp., Texas bergia, 2; l; D,C. FM17800, FM17822

EUPHORBIACEAE

Acalypha ostryifolia Riddell, Rough-pod copperleaf, 1; u; O. FM18330

Chamaesyce fendleri (Torr. & Gray) Small, Fendler's mat-spurge, 4; m; O,D,C. [*Euphorbia fendleri* Torr. & A. Gray – A, F] F16931, FM17552, FM17591, FM17808, MF6098, MF6259

Chamaesyce geyeri (Engelm.) Small, Geyer's mat spurge, 1; s; O. [*Euphorbia geyeri* Engelm. – A, F] FM18356

Chamaesyce glyptosperma (Engelm.) Small, Ridge-seed mat-spurge, 4; s,m; O,D,C. [*Euphorbia glyptosperma* Engelm. – A, F] FM17613, FM17902, FM17941a, FM18280, MF5979, MF6177, MF6299

Chamaesyce maculata (L.) Small, Spotted mat-spurge, 3; l,u; O,D. [*Euphorbia maculata* L. – A, F] FM17621, FM17747, MF5991

Chamaesyce missurica (Raf.) Shinners, Missouri mat-spurge, 2; s,m; D,C. [*Euphorbia missurica* Raf. – A, F] FM17825, MF6402

Chamaesyce nutans (Lag.) Small, Eyebane, Nodding mat spurge, 1; u; O. [*Euphorbia nutans* Lag. – A, F] FM18357

Chamaesyce prostrata (Aiton) Small, Prostrate mat-spurge, 1; u; C. [*Euphorbia prostrata* Aiton – A, F] FM17941b, MF6491

Chamaesyce serpens (Kunth) Small, Round-leaf mat-spurge, 1; l; C. [*Euphorbia serpens* Kunth - A, F] FM17823

Croton glandulosus L. var. *lindheimeri* Müll. Arg., Tropic croton, 2; s,m; O. FM17589, FM18283, MF6433

Croton monanthogynus Michx., One-seed croton, 3; m,s,u; D,C. FM17774, FM17827, FM17896, MF6167

Croton texensis (Klotzsch) Müll. Arg., Texas croton, 3; s,m; O,D,C. FM17538, FM17778, MF6022, MF6168, MF6307

Euphorbia davidii Subils, Western toothed spurge, 3; s,m,u; O,D,C. FM17780, FM17912

Euphorbia longicuris Scheele, Wedge-leaf spurge, 2; m; D,C. F16859, MF6106B, MF6296

Euphorbia marginata Pursh, Snow-on-the-mountain, 3; m; D,C. FM17546, FM17847, FM18279, FM18477

Euphorbia spathulata Lam., Warty spurge, 2; s,m; D,C. MF6106A, MF6236

Stillingia sylvatica L. subsp. *sylvatica*, Queen's-delight stillingia, 2; s; O. FM17655, MF6076

Tragia betonicifolia Nutt., Betony noseburn, 2; s; O. FM17642 , FM17651, MF6047

Tragia ramosa Torr., Catnip noseburn, 3; m; D,C. F16855, FM18410, MF6173, MF6229, MF6405, MF6489

FABACEAE

Acacia angustissima (Mill.) Kuntze var. *hirta* (Nutt.) B.L. Rob., Prairie acacia, 3; s,m; O,D,C. FM17703, FM17923, MF6290, MF6348, MF6471

Amorpha canescens Pursh, Leadplant, 1; s,m; O. FM17610

Amorpha fruticosa L., Bush wild-indigo, 2; m,l; D,C. FM17840, FM17865, MF6317

Astragalus crassicarpus Nutt. var. *crassicarpus*, Ground-plum milk vetch, 2; m; O,D. F16864, MF6081

Astragalus gracilis Nutt., Slender milk-vetch, 2; m; D,C. F16861, MF6092, MF6269

Astragalus lotiflorus Hook., Lotus milk-vetch, 2; m; D,C. F16827, MF6223, MF6343

Astragalus missouriensis Nutt. var. *missouriensis*, Missouri milk-vetch, 2; m; D. F16857, MF6250

Astragalus mollissimus Torr. var. *mollissimus*, Woolly milk-vetch, 2; m; D,C. F16822, MF6247, MF6349

Astragalus nuttallianus DC. var. *austrinus* (Small) Barneby, Small-flower milk-vetch, 1; m; D,C. F16828, F16937

Astragalus plattensis Nutt., Platte River milk-vetch, 2; s,m; O. F16886, MF6055

Baptisia australis (L.) R. Br. var. *minor* (Lehm.) Fernald, Blue wild-indigo, 3; s,m; O,D,C. F16868, F16954, FM17624, MF6191, MF6274

Baptisia bracteata Muhl. ex Elliott var. *leucophaea* (Nutt.) Kartesz & Gandhi, Plains wild-indigo, 4; s,m; O. [*B. bracteata* Muhl. ex Elliott var. *glabrescens* (Larisey) Isley – F; *B. leucophaea* Nutt. – A] F16719, FM17625, MF6075

Chamaecrista fasciculata (Michx.) Greene, Showy partridgepea, 3; s,m; O. [*Cassia chamaecrista* L. – F; *Cassia fasciculata* Michx. – A] FM17587, FM17910, FM18317

Dalea aurea Nutt. ex Pursh, Golden prairie-clover, 3; m; O,D,C. FM17536, FM17752, FM17805

Dalea candida Michx. var. *oligophylla* (Torr.) Shinners, Western prairie-clover, 4; s,m; O,D,C. FM17567, FM17708, FM17832, MF6499

Dalea enneandra Nutt., Nine-anther prairie-clover, 4; s,m; O,D,C. FM17535, FM17601, FM17712, FM17751, FM17806, MF6287, MF6353

Dalea purpurea Vent. var. *arenicola* (Wemple) Barneby, Purple prairie-clover, 1; s; O. MF6007, MF6445

Dalea purpurea Vent. var. *purpurea*, Purple prairie-clover, 3; s,m; O,D,C. FM17537, FM17668, MF6116, MF6288, MF6398, MF6498

Dalea villosa (Nutt.) Spreng. var. *villosa*, Silky prairie-clover, 1; s; O. FM17634

Desmanthus illinoensis (Michx.) MacMill. ex B.L. Rob. & Fernald, Illinois bundle-flower, 2; s,m; O,D,C. FM17524, FM17665, FM17768, FM17874

Desmodium illinoense A. Gray, Illinois tick-clover, 2; w,s; O. FM17695, MF6051, MF6448

Desmodium sessilifolium (Torr.) Torr. & A. Gray, Sessile-leaf tick-clover, 2; s; O. FM17600, FM17925

Gleditsia triacanthos L., Common honey-locust, 1; w; O. MF6000

Glycyrrhiza lepidota Pursh, American licorice, 3; m,r,l; O. FM17608, MF5975

Gymnocladus dioica (L.) K. Koch, Kentucky coffeetree, 2; w,m; C. F16916, FM17819, MF6384

Hedysarum boreale Nutt., Northern sweet-vetch, 1; m; C. FM17540

Indigofera miniata Ort., Western indigo, 3; s; O. [*I. miniata* Ort. var. *leptosepala* (Nutt.) B.L. Turner – A, F] FM17595, MF6010, MF6453

Lespedeza capitata Michx., Round-head bush-clover, 3; s; O. FM17711

Lespedeza stuevei Nutt., Tall bush-clover, Stueve's bush-clover 4; s; O. FM17584, FM18318

**Medicago minima* (L.) L., Prickly medic, 3; m,u; D,C. F16841, F16910, MF6220, MF6344

**Melilotus alba* Medik., White sweet-clover, 2; u; O,C. FM18348, MF6308

**Melilotus officinalis* (L.) Pall., Yellow sweet-clover, 2; u; O,C. MF6205, MF6390, MF6427

Mimosa borealis A. Gray, Fragrant mimosa, 4; s,m; O,D. FM17704, L200-52, MF6086, MF6198

Mimosa quadrivalvis L. var. *nuttallii* (DC.) L.S. Beard ex Barneby, Cat-claw mimosa, 3; s,m; O,D,C. [*Schrankia nuttallii* (DC.) Standl. – A, F] FM17607, MF6128, MF6197, MF6454

Oxytropis lambertii Pursh var. *lambertii*, Lambert's locoweed, 2; m; O,D,C. F16862, FM17526

Pediomelum cuspidatum (Pursh) Rydb., Tall-bread scurfpea, 3; m; D,C. [*Psoralea cuspidata* Pursh – A, F] MF6104, MF6194

Pediomelum digitatum (Nutt.) Isely, Palm-leaf scurfpea, 2; s; O. [*Psoralea digitata* Nutt. var. *digitata* – A, F] FM17574, MF6054

Pediomelum linearifolium (Torr. & A. Gray) J.W. Grimes, Slim-leaf scurfpea, 3; s,m; O,D,C. [*Psoralea linearifolia* Torr. & A. Gray – A, F] FM17558, FM17833, MF6038, MF6084, MF6273

Prosopis glandulosa Torr. var. *glandulosa*, Honey mesquite, 1; m; O,D. FM17561, L2001-112

Psoralidium tenuiflorum (Pursh) Rydb., Narrow leaf scurfpea, 3; s; O. [*Psoralea tenuiflora* Pursh var. *floribunda* (Nutt.) Rydb. – A, F; *P. tenuiflora* Pursh var. *tenuiflora* – A, F] FM17924, MF6023, MF6474

Robinia pseudoacadia L., Black locust, 3; w; O,D,C. F16897, FM18423, MF6313

Strophostyles leiosperma (Torr. & A. Gray) Piper, Slick-seed wildbean, 2; s; O,D. FM17598, FM17797, FM18316, MF6430
Stylosanthes biflora (L.) Britton et al., Two-flower pencil-flower, 1; s; O. FM17572
Tephrosia virginiana (L.) Pers., Goat's-rue, 1; s; O. MF6070
Vicia americana Muhl. ex Willd. var. *minor* Hook., American vetch, 2; m; D. F16874

FAGACEAE

Quercus havardii Rydb., Shinnery oak, 5; s,m; O,D. F16896, F16955, F16956, FM17670, FM17916
Quercus havardii Rydb. × *Quercus stellata* Wangenh., 3; s,m; O. FM17671, L2000-104, L2000 105
Quercus macrocarpa Michx., bur oak, 1; w; O.Ts.n.

FUMARIACEAE

Corydalis aurea Willd. subsp. *occidentalis* (Engelm. ex A. Gray) G.B. Ownbey, Golden fumewort, 1; m; O. F16879

GERANIACEAE

**Erodium cicutarium* (L.) L'Her. ex Aiton, California filaree, 2; u; D,C. F16837, MF6304
Geranium carolinianum L., Carolina crane's bill, 2; s,m,u; O,C. MF5937, MF6262

GROSSULARIACEAE

Ribes odoratum H.Wendl., Buffalo currant, 3; w,m; O. F16891, MF5951

HYDROCHARITACEAE

Najas guadalupensis (Spreng.) Magnus subsp. *guadalupensis*, Common naiad, 4; l; D,C. FM17738, FM17853

IRIDACEAE

Sisyrinchium ensigerum E.P. Bicknell, Sword-leaf blue-eyed grass, 3; w,m; O,D,C. F16858, F16946, MF6261, MF6347, MF6372

JUGLANDACEAE

**Carya illinoinensis* (Wangenh.) K. Koch, Pecan, 1; u; O. L2001-106
Juglans microcarpa Berland., Texas walnut, Little walnut, 4; w,m; O,D,C. FM17692, FM17765, FM18433, FM18461, MF6138, MF6312, MF6385
**Juglans nigra* L., Black walnut, 2; w; O. FM17691, MF5985

JUNCACEAE

Juncus dudleyi Wiegand, Dudley's rush, 2; p,r; O. FM17680, MF5976
Juncus torreyi Coville, Torrey's rush, 3; p,r,l; O,D,C. FM17645, FM17731, FM17743, FM17875

KRAMERIACEAE

Krameria lanceolata Torr., Trailing ratany, Lance-leaf ratany, 3; s,m; O,D,C. FM18374, MF6083, MF6280, MF6351

LAMIACEAE

Hedeoma drummondii Benth., Drummond's false-penny-royal, 3; m; D,C. FM17527, FM17773, FM17892, MF6188
Hedeoma hispida Pursh, Rough false-penny royal, 3; m; O,D,C. F16918, MF6042, MF6111, MF6256
**Lamium amplexicaule* L., Henbit dead-nettle, 1; u; C. F16909
Lycopus americanus Muhl. ex W.P.C. Barton, American water-horehound, 3; p,r,l; O,D,C. FM17636, FM17726, FM17763, FM17889, FM18360, L2001-30
Monarda citriodora Cerv. ex Lag., Lemon bee-balm, 2; m; D,C. FM17932
Monarda clinopodioides A. Gray, Basil bee-balm, 3; m; D,C. MF6091, MF6225
Monarda pectinata Nutt., Plains bee-balm, 2; s; O. MF6472
Monarda punctata L. var. *occidentalis* (Epling) E.J. Palmer & Steyerm., Spotted bee-balm, 2; s; O. MF6015, MF6440
Salvia azurea Michx. ex Lam., Blue sage, Pitcher's sage, 3; m; O,D,C. [*S. pitcheri* Torr. – A] FM17792, FM18278, FM18314, FM18397, FM18422
Scutellaria drummondii Benth. var. *edwardsiana* B.L. Turner, Drummond's skullcap, 1; m; D. MF6162
Scutellaria resinosa Torr., Resinous skullcap, 4; m; O,D,C. F16947, MF6031, MF6098, MF6211, MF6415
Teucrium canadense L. var. *canadense*, American germander, 2; p,r,l; O,C. [*T. canadense* L. var. *virginicum* (L.) Eaton - A] FM17685, FM17884, FM18440
Teucrium laciniatum Torr., Cut-leaf germander, 1; m; D. MF6399

LILIACEAE

Allium canadense L. var. *fraseri* Ownbey, Canadian onion, 2; s,w; O,C. MF6005, MF6374

Allium drummondii Regel, Drummond's onion, 5; m; D. F16824, F16939
Nothoscordum bivalve (L.) Britton, Yellow false-garlic, 1; m; D. F16840

LINACEAE

Linum berlandieri Hook. var *berlandieri*, Berlandier's flax, 2; m; O,C. [L. *rigidum* Pursh var. *berlandieri* (Hook.) Torr. & A. Gray – A, F] F16925, FM17565
Linum pratense (Norton) Small, Norton's blue flax, 4; m; D,C. F16831, F16926, MF6410, MF6500
Linum rigidum Pursh var. *rigidum*, Stiff-stem flax, 4; m; D,C. F16936, MF6143, MF6163

LOASACEAE

Mentzelia decapetala (Pursh) Urb. & Gilg., Ten-petal mentzelia, 1; m; D,C. FM17846
Mentzelia nuda (Pursh) Torr. & A. Gray, Bractless mentzelia, Sand-lily, 4; s,m; O,D,C. FM17543, FM17568, FM17705, FM17815, FM18480
Mentzelia oligosperma Nutt. ex Sims, Stick-leaf, Chickenthief, 1; m; D. MF6400

LYTHRACEAE

Ammannia coccinea Rottb., Purple toothcup, 3; l; D. FM17648, FM17801
Ammannia robusta Heer & Regel, Stout toothcup, 2; l; O,D,C. FM17746, FM17883

MALVACEAE

Callirhoë involucrata (Torr. & A. Gray) A. Gray var. *involucrata*, Winecup, 1; m; D. MF6134
Callirhoë involucrata (Torr. & A. Gray) A. Gray var. *lineariloba* (Torr. & A. Gray) A. Gray, Winecup, 2; m,p; O,C. FM17733, MF5994, MF6196
Sphaeralcea coccinea (Nutt.) Rydb. var. *coccinea*, Scarlet globe-mallow, 2; m; D,C. F16843, F16943, MF6284

MENISPERMACEAE

Cocculus carolinus (L.) DC., Carolina snailseed, 1; p; O. L2001-66

MOLLUGINACEAE

Mollugo verticillata L., Green carpetweed, 3; s,m,u; O,D,C. FM17652, FM17804, FM17826, MF6041

MORACEAE

**Maclura pomifera* (Raf.) C.K. Schneid., Osage-orange, Hedge-apple, 1; w,u; O [see Schambach (2000) for a discussion of the pre-European range of this species in Oklahoma]. FM18337
**Morus alba* L., White mulberry, 1; w; O. MF5953
Morus rubra L., Red mulberry, 1; w; C. FM17872, MF6383

NYCTAGINACEAE

Mirabilis glabra (S. Watson) Standl., Smooth four-o'clock, 2; s; O. FM17614, FM17633
Mirabilis linearis (Pursh) Heimerl var. *linearis*, Narrow-leaf four-o'clock, 3; m; O,D,C. FM17839, FM18464, L2001-09, MF6178, MF6301, MF6422, MF6481

OLEACEAE

Forestiera pubescens Nutt., Downy forestiera, 4; w,s; O,D,C. F16915, FM17628, FM17771, MF6380

ONAGRACEAE

Calylophus berlandieri Spach subsp. *berlandieri*, Berlandier's evening-primrose, 1; s; O. FM 17659, MF6437, MF6438
Calylophus hartwegii (Benth.) P.H. Raven subsp. *pubescens* (A. Gray) Towner & P.H. Raven, Hartweg's evening-primrose, 3; m; D,C. F16904, F16941, MF6096, MF6202
Calylophus lavandulifolius (Torr. & A. Gray) P.H. Raven, Lavender leaf evening-primrose, 1; m; D. MF6089
Calylophus serrulatus (Nutt.) P.H. Raven, Plains yellow evening-primrose, 4; s,m; O,D,C. FM17548, FM17850, MF6009, MF6072, MF6113, MF6201
Epilobium leptophyllum Raf., American marsh willowherb, Slender-fruit willowherb, 1; p,l; O. FM18359
Gaura coccinea Pursh, Scarlet butterfly-weed, 3; m; D,C. F16833, F16902, MF6239
Gaura parviflora Douglas, Velvet butterfly-weed, 3; s,m,u; O,D,C. FM17631, FM17753, FM17830, FM18371, FM18454, MF6185, MF6289
Gaura villosa Torr. subsp. *villosa*, Hairy butterfly-weed, 3; s,m; O. FM17594, FM18370, MF6017, MF6457
Oenothera laciniata Hill, Cut-leaf evening-primrose, 2; s,m; O. F16881, MF5948, MF6483
Oenothera macrocarpa Nutt. subsp. *incana* (A. Gray) W.L. Wagner, Gray evening-primrose, 3; m; D,C. F16854, FM17542, FM17897, MF6129, MF6411
Oenothera rhombipetala Nutt., Four-point evening-primrose, 1; s; O. FM17641
Oenothera triloba Nutt., Stemless evening-primrose, 1; m; C. F16928

Stenosiphon linifolius (Nutt.) Heynh., Stenosiphon, 4; s,m; D,C. FM17534, FM17750, FM17812, FM17935, FM18281, FM18391, MF6102

OXALIDACEAE

Oxalis dillenii Jacq. subsp. *dillenii*, Gray-green wood-sorrel, 2; m,u; O,D,C. F16929, MF6053, MF6345, FM18470

Oxalils violacea L., Violet wood-sorrel, 1; s,m; O,D. F16917

PAPAVERACEAE

Argemone polyanthemos (Fedde) G.B. Ownbey, Plains prickly-poppy, 2; m; O,D. FM18432, MF6058

PEDALIACEAE

Proboscidea louisianica (Mill.) Thell., Common devil's-claw, 1; l,u; D. FM17802

PHYTOLACCACEAE

Phytolacca americana L. var. *americana*, American pokeweed, 3; w,u; O,D. FM17736, FM18414, MF5941

PLANTAGINACEAE

Plantago patagonica Jacq. var. *patagonica*, Woolly plantain, 4; s,m; O,D,C. MF5959, MF6016, MF6112, MF6209, MF6340

Plantago patagonica Jacq. var. *spinulosa* (Decne.) A. Gray, Bristle-bract plantain, 3; s,m; O,D. MF6079, MF6121, MF6339

Plantago rhodosperma Decne., Red-seed plantain, 3; s,m,u; O,D,C. F16924, MF6052, MF6100, MF6208, MF6389

POACEAE

**Aegilops cylindrica* Host, Jointed goat grass, 2; u; D,C. MF6183, MF6245

**Agrostis gigantea* Roth, Spreading redtop, 1; r; O. FM17681

Andropogon hallii Hack., Sand bluestem, 5; s,m; O,D,C. FM17550, FM17784, FM17908, FM17928, FM18293, FM18406, FM18458

Aristida basiramea Engelm. ex Vasey, Fork-tip threeawn, 1; s; O. FM18291, FM18369

Aristida oligantha Michx., Old-field threeawn, 2; s,m,u; O. FM17571, FM17644, FM18289, FM18366

Aristida purpurascens Poir. var. *purpurascens*, Arrow-feather threeawn, 3; s,m; O. FM17700, FM18290

Aristida purpurea Nutt. var. *longiseta* (Steud.) Vasey, Purple threeawn, 1; m; D. [*A. longiseta* Steud. – A; *A. purpurea* Nutt. var. *robusta* (Merr.) A.H. Holmgren & N.H. Holmgren – F] MF6114

Aristida purpurea Nutt. var. *purpurea*, Purple threeawn, 3; s,m; O,D,C. [*A. roemeriana* Scheele – A, F] FM17701, FM17848, MF6049, MF6213, MF6403, MF6477

Aristida purpurea Nutt. var. *wrightii* (Nash) Allred, Purple threeawn, 5; m; O,D,C. [*A. wrightii* Nash – A] FM17533, FM17556, FM17788, MF6181, MF6478

**Avena fatua* L. wild oats 1; u; D. MF6187

**Bothriochloa ischaemum* (L.) Keng var. *songarica* (Rupr. ex Fisch. & C.A. Mey.) Celarier & J.R. Harlan, Turkestan bluestem, 4; s,m,u; O,D,C. [*Andropogon ischaemum* L. var. *songaricus* Rupr. ex Fisch. ex C.A. Mey. – A, F] FM17660, FM17901, FM18384, FM18476, MF5988, MF6335, MF6368

Bothriochloa laguroides (DC.) Herter subsp. *torreyana* (Steud.) Allred & Gould, Silver bluestem, 3; m,u; O,D,C. [*Andropogon saccharoides* Sw. – A; *A. saccharoides* Sw. var. *torreyanus* (Steud.) Hack. – F] FM17555, FM17790, FM17831, MF6021, MF6135, MF6244

Bouteloua curtipendula (Michx.) Nash var. *curtipendula*, Side oats grama, 5; s,m; O,D,C. FM17531, FM17566, FM17789, FM17813, MF6171, MF6310

Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths, Blue grama, 2; m; C. L2001-98, MF6311

Bouteloua hirsuta Lag. var. *hirsuta*, Hairy grama, 4; s,m; O,D,C. FM17539, FM17609, FM17777, MF6172

**Bromus catharticus* Vahl var. *catharticus*, Rescue brome, 3; u; O,D,C. [*B. unilioides* Kunth – A, F] F16839, MF5957, MF6182, MF6216

**Bromus japonicus* Thunb., Japanese brome, 3; u; O,D,C. F16953, MF5958, MF6117, MF6215, MF6476

Buchloë dactyloides (Nutt.) Engelm., Buffalo grass, 4; m; O,D,C. F16933, MF6043, MF6164, MF6219

Cenchrus spinifex Cav., Coast sandbur, 4; s,u; O. [*C. incertus* M.A. Curtis – A, F] FM17649, MF5993

Chloris verticillata Nutt., Whorled windmill grass, 3; u; O,D,C. MF6166, MF6333, MF6480

Chloris virgata Sw., Showy windmill grass, 1; u; O,C. FM17845, FM18913

**Cynodon dactylon* (L.) Pers., Common Bermuda grass, 2; u; O,C. FM17882, MF5956

Dichanthelium oligosanthes (Schult.) Gould var. *scribnerianum* (Nash) Gould, Scribner's panicum, 3; w,s; O,C. MF5936, MF6035, MF6367, MF6484

**Digitaria ciliaris* (Retz.) Koeler, Southern crab grass, 1; u; O. [*D. adscendens* (Kunth) Henrard – A] FM17696

Digitaria cognata (Schult.) Pilg. subsp. *cognata*, Fall witch grass, 3; s,m; O. [*Leptoloma cognatum* (Schult.) Chase – A, F] FM17619, FM18285, MF6466

**Digitaria sanquinalis* (L.) Scop., Hairy crab grass, 2; u; O. FM17909, FM18342, MF5978

**Echinochloa crusgalli* (L.) P. Beauv., Common barnyard grass, 3; l,u; O,C. FM17612, FM17937, FM18376

Echinochloa muricata (P. Beauv.) Fernald var. *microstachya* Wiegand, Rough barnyard grass, 2; p,r,l; D,C. FM17794, FM18452, L2001 31

Echinochloa muricata (P. Beauv.) Fernald var. *muricata*, Rough barnyard grass, 3; p,r; O,D,C. FM17686, MF6156, MF6249, MF6394

Elymus canadensis L. var. *canadensis*, Canadian wild-rye, 3; w,s,m; O,D,C. MF5989, MF6151, MF6266, MF6432

Elymus virginicus L. var. *virginicus*, Virginia wild-rye, 2; w,m; O,C. FM17549, L2001-117, MF6377

**Eragrostis barrelieri* Daveau, Mediterranean love grass, 1; u; O,C. FM18381a, FM18468

**Eragrostis cilianensis* (All.) Vignolo ex Janch., Stink grass, 2; u; O,D. FM17563, FM17793, FM18334

Eragrostis curtipedicellata Buckley, Gummy love grass, 1; w; O. FM17682

**Eragrostis curvula* (Schrad.) Nees var. *conferta* Stapf, Weeping love grass, 3; s,m,u; O,D,C. FM17569, FM17787, MF5963, MF6393, MF6434, MF6455

Eragrostis pectinacea (Michx.) Nees var. *pectinacea*, Carolina love grass, 3; u; O. FM17602, FM18381b, MF5977

Eragrostis secundiflora C. Presl subsp. *oxylepis* (Torr.) S.D. Koch, Red love grass, 1; s; O. [*E. oxylepis* (Torr.) Torr. – A] FM17564

Eragrostis sessilispica Buckley, Tumble love grass, 2; s; O. MF6048, MF6467

Eragrostis spectabilis (Pursh) Steud., Purple love grass, 2; s,m; O,C. FM18286, FM18445

Eragrostis trichodes (Nutt.) A.W. Wood, Sand love grass, 2; s; O. FM18288

Eriochloa contracta Hitchc., Prairie cup grass, 1; l; D. FM17795

Erioneuron pilosum (Buckley) Nash var. *pilosum*, Hairy tridens, 4; s,m; O,D,C. [*Tridens pilosus* (Buckley) Hitchc. – A, F] MF6087, MF6221, MF6464

Hordeum jubatum L., Fox-tail barley, Squirrel-tail grass, 3; s,m,l; D. MF5968, MF6184

Hordeum pusillum Nutt., Little barley, 4; s,m; O,D,C. MF5992, MF6157, MF6218

Leersia oryzoides (L.) Sw., Rice cut grass, 3; p,r,l; O,C. FM17688, FM18351, FM18447

**Lolium perenne* L. var. *aristulatum* Willd., Perennial rye grass, 1; u; D. MF6180

Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi, Alkali muhly, Scratch grass, 3; r,l; O,D. FM17637, FM18347, FM18434

Muhlenbergia mexicana (L.) Trin., Mexican wire-stem muhly, 1; w; C. FM17818

Muhlenbergia racemosa (Michx.) Britton et al., Marsh muhly, 1; w,p,r; O. FM18344

Muhlenbergia sobolifera (Muhl. ex Willd) Trin., Rock muhly, 1; w; O. FM18345

Panicum capillare L. var. *barbipulvinatum* (Nash) McGregor, Common witch grass, 2; l; C. FM18438

Panicum capillare L. var. *brevifolium* Vasey ex Rydb. & Shear, Common witch grass, 2; w; O. FM17675, FM18296

Panicum dichotomiflorum Michx., Fall panicum, 2; l,u; O. FM17618

Panicum hillmanii Chase, Hillman's panicum, 2; s,r; O. FM17570

Panicum virgatum L., Switch grass, 2; m,r,l; O,D,C. FM17617, FM17782, FM17866, FM18287

Pascopyrum smithii (Rydb.) Á. Löve, Western pasture-wheat, Western wheat grass, 4; m,r,l; O,D,C. [*Agropyron smithii* Rydb. – A, F] MF6040, MF6159, MF6268, MF6396

Paspalum setaceum Michx. var. *stramineum* (Nash) D.J. Banks, Thin paspalum, 3; s; O. FM17643, MF5972, MF6479

Phalaris caroliniana Walter, Reed canary grass, 2; r,l,u; O,D. MF5961, MF6132

**Poa annua* L., Annual blue grass, 1; m,u; C. F16934

Poa arachnifera Torr., Texas blue grass, 1; s; O. MF6034

Poa arida Vasey, Plains blue grass, 4; w,m; O,D. F16870, F16885, F16903

**Polypogon monspeliensis* (L.) Desf., Annual rabbit's-foot grass, 2; p,r,l; O,C. MF5966, MF6243

Schedonnardus paniculatus (Nutt.) Trel., Tumble grass, 2; s,m; O,D,C. MF6165, MF6217, MF6465

Schizachyrium scoparium (Michx.) Nash subsp. *scoparium*, Little bluestem, 5; s,m; O,D,C. [*Andropogon scoparius* Michx. – A, F] FM 17531, FM17596, FM17785, FM17895, FM18400

**Secale cereale* L., Rye, 1; u; O. MF6012, MF6460

Setaria parviflora (Poir.) Kerguélen, Knot-root bristle grass, 4; p,r,l; O,D,C. [*S. geniculata* (Lam.) P. Beauv. – A, F] FM17583, FM17723, FM17744, FM17886

**Setaria viridis* (L.) P. Beauv., Green bristle grass, 3; u; O,C. FM17697, FM17911, MF5947, MF6376

Sorghastrum nutans (L.) Nash, Indian grass, 4; s,m,r; O,D,C. FM17786, FM18352, FM18460

**Sorghum halepense* (L.) Pers., Johnson grass, 3; u; O,D,C. FM17669, FM18326, MF6423, MF6450, MF6492

Sphenopholis obtusata (Michx.) Scribn. var. *obtusata*, Prairie wedgescale, 1; w; O. MF5962

Sporobolus clandestinus (Biehler) Hitchc., South-eastern dropseed, 2; s; O. [*S. asper* (P. Beauv.) Kunth var. *clandestinus* (Biehler) Shinners – A, F] FM18294

Sporobolus compositus (Poir.) Merr. var. *compositus*, Tall dropseed, 4; m; D. [*S. asper* (P. Beauv.) Kunth – A, F] FM18401

Sporobolus cryptandrus (Torr.) A. Gray, Sand dropseed, 4; s,m,u; O,D,C. FM17551, FM17915, L2001-40, MF6179, MF6334, MF6485

Sporobolus vaginiflorus (Torr. & A. Gray) A.W. Wood, Poverty dropseed, 3; u; O,C. FM18277, FM18367

Tridens albescens (Vasey) Wooton & Standl., White tridens, 3; w,m,l; D,C. FM17554, L2001-34, MF6160, MF6251

Tridens flavus (L.) Hitchc. var. *flavus*, Purpletop, 3; w,s,m,u; O,C. FM17677, FM18295, FM18451

Tridens muticus (Torr.) Nash var. *elongatus* (Buckley) Shinners, Slim tridens, 1; m; C. FM18450

Triplasis purpurea (Walter) Chapm. var. *purpurea*, Purple sand grass, 2; s; O. FM18292

Trisetum interruptum Buckley, Prairie trisetum, 3; s,m; D,C. MF6088, MF6214

**Triticum aestivum* L., Bread wheat, 1; u; D. MF6115

Vulpia octoflora (Walter) Rydb. var. *glauca* (Nutt) Fernald, Six-weeks annual-fescue, 4; m; O,D,C. [*Festuca octoflora* Walter – A, F] FL16834, FL16884, MF5960, MF6203, MF6475

POLEMONIACEAE

Ipomopsis longiflora (Torr.) V.E. Grant, Long-flower ipomopsis, 2; s,m; O,C. FM18368, Ts.n.

POLYGALACEAE

Polygala alba Nutt., White milkwort, 3; s,m; O,D,C. F16923, MF6067, MF6105, MF6204

Polygala verticillata L., Whorled milkwort, 2; s; O. FM17674, FM17707, MF6063

POLYGONACEAE

Eriogonum alatum Torr. var. *glabriusculum* Torr., Winged wild-buckwheat, 4; m; O,D,C. FM17544, FM17623, FM17757, FM17809, FM18390, FM18479, L2000-83, L2001-19, L2001-75

Eriogonum annuum Nutt., Annual wild-buck-wheat, 4; s,m; O,D,C. FM17575, FM17891, FM17922, FM18320, FM18388, L2001 88

Eriogonum longifolium Nutt. var. *longifolium*, Lance-leaf wild-buckwheat, 4; s,m; O,D,C. FM17545, FM17585, FM17756, FM17810, FM18389, FM18478, L2001-15, MF6286

**Polygonum arenastrum* Boreau, Sand knotweed, Doorweed, 3; u; O,C. MF5996, MF6237, MF6388

Polygonum lapathifolium L., Pale smartweed, Dock-leaf smartweed, 2; r,l; O,D,C. FM17749, FM18353, L2001-84, MF6248

Polygonum ramosissimum Michx., Bushy knot-weed, 2; w; O,D. FM17715, FM18354, L2001-21

Polygonum tenue Michx., Pleat-leaf knotweed, Slim knotweed, 2; s; O. FM17635, FM17699, FM18284

Rumex altissimus A.W. Wood, Pale dock, 2; l; C. MF6315

**Rumex crispus* L., Curly dock, 2; l,u; O,D,C. MF5942, MF6369

PORTULACACEAE

Portulaca oleracea L., Common purslane, 2; s,l,u; O,D,C. FM17577, F17799, FM17824

Talinum calycinum Engelm., Rock pink fameflower, 1; s; O. FM17737

POTAMOGETONACEAE

Potamogeton nodosus Poir., Long-leaf pondweed, 3; l; D,C. FM17854, FM18413

Stuckenia pectinata (L.) Börner, Sago pondweed, 2; l; O,D,C. [*Potamogeton pectinatus* L. – A, F] FM17844, FM18375, MF6329

PRIMULACEAE

Androsace occidentalis Pursh, Western rock-jasmine, 2; m; O,D. F16830, F16894

Samolus parviflorus Raf., Small water-pimpernel, 3; p,r,l; O,D,C. FM17724, FM17758, FM17857, FM18441, MF5967

RANUNCULACEAE

Anemone berlandieri Pritz., Ten-petal anemone, 3; m; O,D,C. F16872

Delphinium carolinianum Watler subsp. *virescens* (Nutt.) R.E. Brooks, Plains larkspur, 2; s,m; O,D,C. [*D. virescens* Nutt. – A; *D. virescens* Nutt. subsp. *penardii* (Huth) Ewan – F] MF6032, MF6145, MF6193

Ranunculus cymbalaria Pursh, Shore buttercup, 2; l; D,C. FM17880, FM18443

Ranunculus sceleratus L. var. *sceleratus*, Cursed crowfoot, Blister buttercup, 2; l; O,C. FM18442, MF5969, MF6282

RHAMNACEAE

Ceanothus herbaceus Raf., Inland ceanothus, 3; s,m; O,D,C. [*C. herbaceus* Raf. var. *pubescens* (Torr. & A. Gray ex S. Watson) Shinners – A, F] F16844, FM17520, FM17781, MF6001

ROSACEAE

Geum canadense Jacq., White avens, 2; w; O,C. MF5935, MF6365

Potentilla paradoxa Nutt., Bushy cinquefoil, 2; l; D,C. FM17742, FM18455

Prunus angustifolia Marshall, Chickasaw plum, Sandhill plum, 3; s,m; O,D,C. MF6060, MF6322, MF6323, MF6355, MF6459

Prunus gracilis Engelm. & A. Gray, Oklahoma plum, 2; s; O. F16883, FM17627, MF6429, MF6458

Rubus bushii L.H. Bailey, Bush's blackberry, 1; w; O. MF5964

RUBIACEAE

Cephalanthus occidentalis L., Common buttonbush, 3; m,r,l; D,C. FM17764, FM17867

Galium aparine L., Catch-weed bedstraw, 2; w,u; O,C. F16912, MF5939, MF6303

Galium circaezans Michx., Forest bedstraw, 3; w; O,C. FM17870, MF5938, MF6363

Hedyotis nigricans (Lam.) Fosberg var. *nigricans*, Narrow-leaf bluets, 3; s,m; O,D,C. FM17706, MF6019, MF6097, MF6246, MF6416

SALICACEAE

Populus deltoides W. Bartram ex Marshall subsp. *monilifera* (Aiton) Eckenw., Plains cottonwood, 5; w,m; O,D,C. F16905, FM18383, MF6319, MF6456

Salix exigua Nutt. subsp. *interior* (Rowlee) Cronquist, Sandbar willow, 2; w,r,l; O,D,C. F16906, FM17729, FM17766, FM18425

Salix nigra Marshall, Black willow, 2; w,r,l; O,C. F16889, MF6279

SANTALACEAE

Comandra umbellata (L.) Nutt. subsp. *pallida* (A. DC.) Piehl, Umbellate bastard toad-flax, 2; m; D,C. F16851, MF6295

SAPINDACEAE

Sapindus saponaria L. var. *drummondii* (Hook. & Arn.) L.D. Benson, Southern soapberry, 3; w,m; D,C. [*S. drummondii* Hook. & Arn. – A] FM17820, MF6325

SAPOTACEAE

Sideroxylon lanuginosum Michx. subsp. *oblongifolium* T.D. Penn., Woolly jungle plum, Chittimwood, 3; w,m; O,D,C. [*Bumelia lanuginosa* (Michx.) Pers. var. *oblongifolia* (Nutt.) R.B. Clark – A, F] FM17816, FM18338, FM18430, MF5995, MF6324

SCROPHULARIACEAE

Agalinis aspera (Douglas ex Benth.) Britton, Rough agalinis, 2; m; D,C. FM18387, L2001-10, L2001-73

Castilleja purpurea (Nutt.) G. Don var. *citrina* (Pennell) Shinners, Citron paintbrush, 3; m; O,D,C. F16860, F16942, MF6306, MF6497

Castilleja sessiliflora Pursh, Downy paintbrush, 3; m; D. F16846

Nuttallanthus texanus (Scheele) D.A. Sutton, Texas toad-flax, 3; s; O. [*Linaria canadensis* (L.) Dumort. var. *texana* (Scheele) Pennell – A, F] F16888

Penstemon albidus Nutt., White beardtongue, 4; m; D,C. F16900, MF6253, MF6341

Penstemon buckleyi Pennell, Buckley's beard-tongue, 2; s; O. F16877, MF6452

Penstemon cobaea Nutt. var. *cobaea*, Cobaea beardtongue, 3; m; D,C. FM17523, L2001-93, MF6101, MF6190, MF6401

Penstemon fendleri Torr. & A. Gray, Fendler's beard-tongue, 2; m; D. F16823, MF6342

**Veronica catenata* Pennell, Blue water speed-well, 2; p,r; O. MF5965

Veronica peregrina L. subsp. *xalapensis* (Kunth) H. St. John & F.A. Warren, Purslane speedwell, 2; w,m,l; D. F16842, MF6356

SMILACACEAE

Smilax hispida Muhl. ex Torr., Bristly greenbrier, 1; w; C. MF6382

SOLANACEAE

Chamaesaracha coniodes (Moric. ex Dunal) Britton, Dusty false-nightshade, 2; m; D,C. F16867, MF6169, MF6264

Datura inoxia Mill., Hairy thorn-apple, 1; w,u; O. [*D. meteloides* DC. – A; *D. wrightii* Regel – A] FM18331

Physalis cinerascens (Dunal) Hitchc. var. *cinerascens*, Ashy ground-cherry, 3; w,s,m; O,D,C. [*P. viscosa* L. subsp. *mollis* (Nutt.) Waterf. var. *cinerascens* (Dunal) Waterf. – F; *P. viscosa* L. var. *cinerascens* (Dunal) Waterf. – A] FM17684, MF6109, MF6174, MF6240, MF6496

Physalis longifolia Nutt. var. *longifolia*, Long-leaf ground-cherry, 3; s,m; O,C. MF6425, MF6426, MF6495

Quincula lobata (Torr.) Raf., Purple ground-cherry, 3; m,u; D,C. F16852, MF6175, MF6241

Solanum dimidiatum Raf., Western horse-nettle, 3; s,m; O,D,C. FM17710, FM18900, FM17927, FM18429, MF6057

Solanum elaeagnifolium Cav., Silver-leaf night-shade, 3; s,m; O,D,C. FM17829, MF5984, MF6126, MF6227, MF6493

Solanum interius Rydb., Plains black nightshade, 1; u; C. FM18469

Solanum rostratum Dunal, Buffalo bur night-shade, 2; s,m,l,u; O,D,C. FM17620, MF6155, MF6226

TAMARICACEAE

**Tamarix ramosissima* Ledeb., Salt-cedar, 2; p,r,l; O,D,C. FM17760, MF5983, MF6321

TYPHACEAE

Typha domingensis Pers., Southern cat-tail, 4; p,l; O,C. FM17622, FM17687, FM17878, FM18378

ULMACEAE

Celtis laevigata Willd., Sugar hackberry, Sugar-berry, 1; w; C. MF6381

Celtis reticulata Torr., Net-leaf hackberry, 4; w,m; O,D,C. F16882, FM18358, MF5954, MF6141, MF6326

Ulmus americana L., American elm, 4; w; O,D,C. F16871, MF5952, MF6142, MF6320

URTICACEAE

Parietaria pensylvanica Muhl. ex Willd., Pennsyl-vania pellitory, 2; w,m; O,C. F16895, MF6281, MF6371

VERBENACEAE

Glandularia bipinnatifida (Nutt.) Nutt. var. *bipinnatifida*, Dakota vervain, 3; m; D,C. [*Verbena bipinnatifida* Nutt. – A, F] F16920, MF6147, MF6270

Phyla lanceolata (Michx.) Greene, Northern fogfruit, Lance-leaf fogfruit, 2; p,l; O,C. [*Lippia lanceolata* Michx. – F] FM17722, FM17887

Phyla nodiflora (L.) Greene, Turkey-tangle, Com-mon fogfruit, 3; l; D,C. [*Lippia nodiflora* (L.) Michx. var. *nodiflora* – F; *P. incisa* Small – A] FM17745, FM17828, FM17862, FM18453, MF6150, MF6309

Verbena bracteata Lag. & Rodr., Prostrate vervain, 2; u; O,D,C. L2001 24, MF5980, MF6271

Verbena hastata L., Blue vervain, 1; p,r; O. FM17720

Verbena stricta Vent., Hoary vervain, 2; s,m,u; O,C. FM17605, FM17885

Verbena urticifolia L., Nettle-leaf vervain, 2; w; O. FM17676

VIOLACEAE

Viola bicolor Pursh, Johnny-jump-up, 3; w,u; O,C. [*V. rafinesquii* Greene – A, F] F16907, MF6078

Viola pratincola Greene, Meadow violet, 1; w,r; O. F16893

VITACEAE

Ampelopsis cordata Michx., Heart-leaf raccoon-

grape, 3; w; O,C. FM17690, FM17730, FM17783, FM17871, MF5944, MF6391

Parthenocissus quinquefolia (L.) Planch., Virginia creeper, 3; w; O,D,C. FM17673, FM17770, MF5946, MF6328, MF6387

Parthenocissus vitacea (Knerr) Hitchc., Thicket creeper, Woodbind, 2; w; D. FM18427

Vitis acerifolia Raf., Bush grape, 3; w,s,m; O,D,C. FM17864, FM18426, MF6059, MF6158, MF6276

ZYGOPHYLLACEAE

**Tribulus terrestris* L., Spreading puncturevine, Goat's head, 1; u; D. FM17943

ACKNOWLDEGMENTS

The Dempsey Divide Research Foundation, Inc., the R. L. McGregor Herbarium, and the Kansas Biological Survey provided financial support for this study. We thank Hillary Loring and Kelly Kindscher for their assistance in the field and for their review of the draft manuscript. Ronald McGregor, Bruce Hoagland, and Adam Ryburn also reviewed the manuscript and offered numerous helpful suggestions. Jennifer Delisle kindly prepared the map.

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BOOK NOTICES

W.T. Parsons and E.G. Cuthbertson. 2001. **Noxious Weeds of Australia, Second Edition.** (ISBN 0643065148, hbk.). CSIRO Publishing, PO Box 1139, Collingwood Vic 3066, AUSTRALIA. (Orders: Antipodes Books & Beyond Ltd (USA & Canada), 9707 Fairway Ave., Silver Spring, MD 20901-3001, U.S.A., 301-602-9519, fax 301-565-0160, email: antipode@antipodesbooks.com, www.antipodesbooks.com or CSIRO Publishing, publishing.sales@csiro.au, www.publish.csiro.au). AU$195.00, 712 pp., color throughout, maps, 7 1/4" × 10 1/4".

The first edition of *Noxious Weeds of Australia* was published in 1992. From the back cover: "Since the first edition of *Noxious Weeds of Australia*, numerous changes have taken place throughout Australia to the legal requirements for the control of proclaimed weeds and the manner in which they are classified. In this second edition, the authors have completely updated this information for each State and Territory and have listed the newly proclaimed weeds in an addendum. The list of herbicides and their properties has also been revised."

The intended audience according to the authors is "farmers, agricultural advisers, environmentalists, ecologists, representatives of agricultural chemical companies, stock and station agents, herbicide applicators, administrators, students of agriculture and anyone else with an interest." But with information on over 200 species including nomenclature, habitat, description, and distribution maps, and the occasional line drawing, the book will also be useful to the botanist and taxonomists. Many of the weeds covered in this book are widespread making the book useful beyond Australia.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

Lena Struwe and Victor A. Albert (Editors). 2002. **Gentianaceae: Systematics and Natural History.** (ISBN 0-521-80999-1, hbk.). Cambridge University Press, The Edinburgh Bldg., Cambridge CB2 2RU, U.K. (Orders: 40 West 20th ST., New York, NY 10011-4211, U.S.A. www.cup.org, www.cup.cam.ac.uk). $130.00, 652 pp., b/w photos, line drawings, graphs, 6" × 9".

This volume is a comprehensive review of the Gentianceae family including the latest information on phylogeny, classification, biogeography, palynology, phytochemistry, and morphology. "Descriptions of each of the 87 gentian genera are provided, as are discussions on morphological evolution and biogeography for each major evolutionary lineage."

Contents: **1)** Gentianaceae in context (V.A. Albert and L. Struwe); **2)** Systematics, character evolution, and biogeography of Gentianaceae, including a new tribal and subtribal classification (L. Struwe, J.W. Kadereit, J. Klackenberg, S. Nilsson, M. Thiv, K.V. von Hagen, and V.A. Albert); **3)** Cladistics of Gentianaceae: a morphological approach (S. Mészáros, J. De Laet, V. Goethals, E. Smets, and S. Nilsson; **4)** Gentianaceae: a review of palynology (S. Nilsson); **5)** The seeds of Gentianaceae (F. Bouman, L. Cobb, N. Devente, V. Goethals, P.J.M. Maas, and E. Smets); **6)** Chemotaxonomy and pharmacology of Gentianaceae (S.R. Jensen and J. Schripsema); and Index.

WEST GULF COASTAL PLAIN ECOREGIONS

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ABSTRACT

We review the literature on West Gulf Coastal Plain ecoregions and examine the methodology used by ecoregion mappers. Ecoregion mapping has been done almost entirely without quantitative assessment. We suggest that quantitative descriptions should replace impressionistic descriptions.

KEY WORDS: West Gulf Coastal Plain, Ecoregions

RESUMEN

Hemos revisado la bibliografía de las ecorregiones de la West Gulf Coastal Plain y examinado la metodología usada por los cartógrafos de ecorregiones. La cartografía ecorregional ha sido realizada casi totalmente sin evaluación cuantitativa. Sugerimos que las descripciones cuantitativas deben reemplazar a las descripciones impresionistas.

INTRODUCTION

Half a century ago, Webb (1950) examined the methodology of biogeographers who had mapped Texas and Oklahoma ecoregions. He found not only that ecoregional mappers did not agree among themselves but that ecoregional mapping was subjective. He suggested a remedy: "quantitative methods must be developed before general agreement on the extent of the major [ecoregions] can be reached. As long as personal opinion and individual judgment are the only basis for judging the extent of the [ecoregions], fundamental and insoluble differences of opinion will continue" (Webb 1950:246). Using vertebrates, he quantitatively assessed the ecoregions of Texas and Oklahoma. His ecoregions did not correspond with those developed by botanists and botanically oriented ecologists. A decade and a half later, Gleason and Cronquist (1964:177), referring to the entire North American continent, reiterated Webb's point in almost the same words but made no quantitative analysis. More recently, Hargrove and Luxmoore (1998), again looking at the entirety of North America, recognized the same thing: "Because the delineation [of ecoregions] is based on subjective criteria, there are as many sets of ecoregions as there are experts."

These assertions prompted us to examine the history of floristic ecoregion delineation in the West Gulf Coastal Plain (WGCP). We will be concerned

mainly with three ecoregions: Longleaf Pine (LLP), Post Oak Savanna (POSa), and Oak-Pine-Hickory (OPH). One of the traditional designations and locations of these WGCP ecoregions is given in Figure 1.

There are numerous descriptions of each of these ecoregions (e.g., Tharp 1939; Gould 1962; Correll & Johnston 1970; LBJ School of Public Affairs 1978; Hatch et al. 1990; Telfair 1999). The lack of pines, the codominance of oaks and hickories, and the ubiquitous presence of *Quercus stellata* Wang. are always emphasized when the POSa region is described, the combination of pines, oaks, and hickories is emphasized in the description of the OPH ecoregion, and the LLP ecoregion is defined as being coterminous with the distribution of *Pinus palustris* Mill.

METHODS

1. Ecoregional mappers.—We surveyed the ecoregional literature dealing with the eastern part of the WGCP to see if Webb (1950), Gleason and Cronquist (1964), and Hargrove and Luxmoore (1998) were correct in their assessment of ecoregional mapping. The literature dealing directly or indirectly with the ecoregions of this area is extensive (Cooper 1859; Transeau 1903; Harshberger 1911; Shreve 1917; Shantz & Zon 1924; Tharp 1926, 1939, 1952; Carter 1931; Fenneman 1938; Dice 1943, 1968; Blair 1950; Braun 1950; Turner 1959; Gould 1962; Gleason & Cronquist 1964; Kuchler 1964; Kuchler & McCormick 1965; LBJ School of Public Relations 1978; Bailey 1980; McMahan et al. 1984; Omernik 1986; Takhtajan 1986; Diamond et al. 1987; De Graaf et al 1988; Diamond & Smeins 1988; Greller 1988; Barbour & Christensen 1993; Thorne 1993; Bailey et al. 1994; McNab & Avers 1994; Keys et al. 1995; Weakley et al. 1998; Diggs et al. 1999; Ricketts et al. 1999a, 1999b; Delcourt & Delcourt 2000). Mappers are discussed and their maps reproduced in the Appendix.

2. Floristics.—We made a number of quantitative ecoregional comparisons to see how similar or different these regions are. Since there is no complete floristic survey of any of the WGCP ecoregions, we had to rely on floristic lists from each (e.g., Anon. n.d.; McBryde 1933; Matos & Rudolph 1985; Nixon 1985; Bridges & Orzell 1989; Hatch et al. 1990; Orzell 1990; Louisiana Natural Heritage Program 1998; Turner et al. 1999; Van Kley 1999a, 1999b; MacRoberts & MacRoberts 2001), which we have compared with distributional data given in various floras, atlases, and plant lists (e.g., Smith 1988; MacRoberts 1989; Taylor & Taylor 1989; Hatch et al. 1990; Thomas & Allen 1993-1998; Kartesz & Meacham 1999; Turner 2003) and community classifications (Diamond et al. 1987; Louisiana Natural Heritage Program 1998; Bezanson 2000). To establish the existence of different floristic ecoregions one would expect there to be 1) significant regional floristic differences between ecoregions, 2) significant regional community differences between ecoregions, and 3) higher similarity within different parts of an ecoregion than between ecoregions. We were unable to compare species abundances between regions since the data are not available.

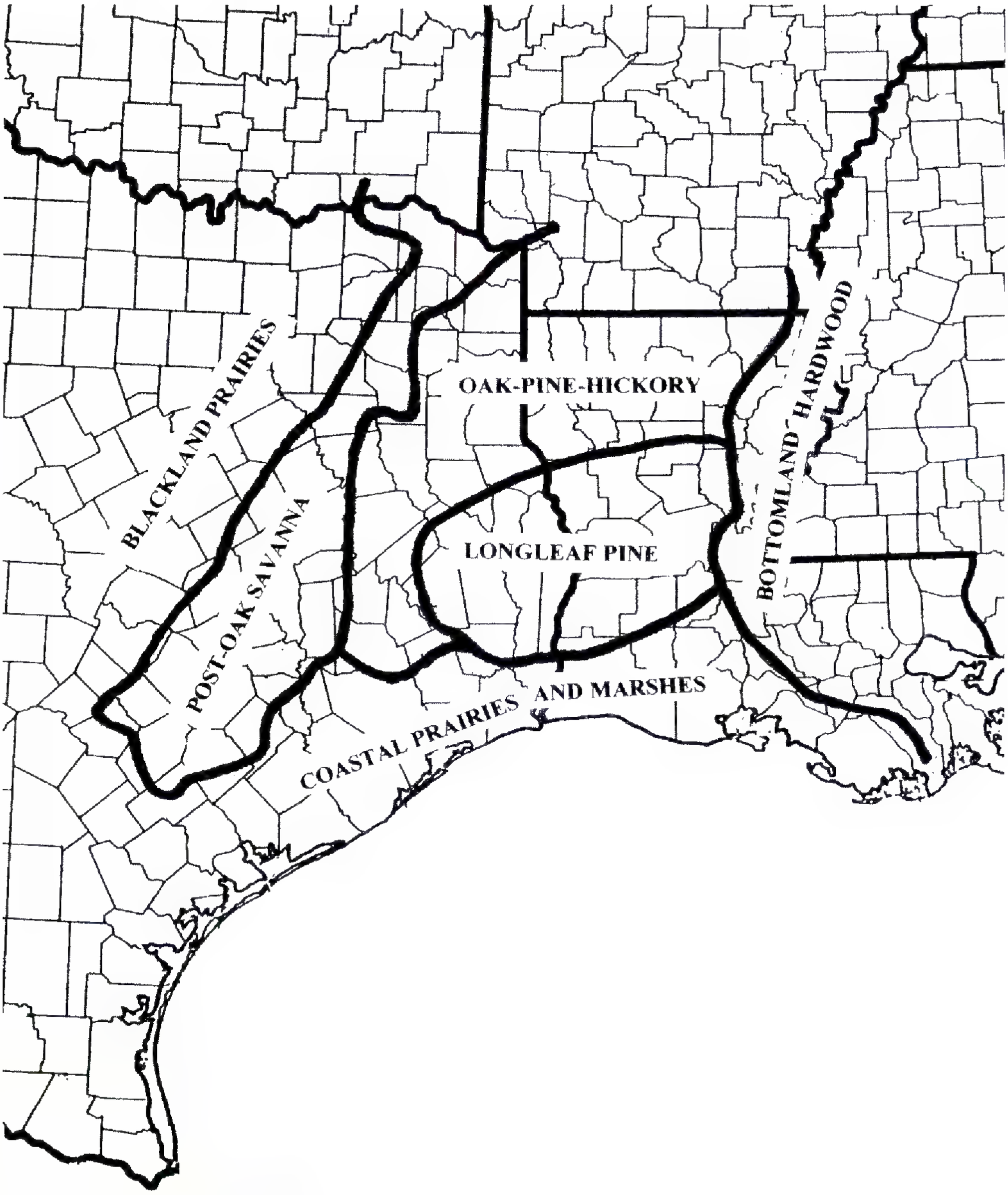


FIG. 1. Standard location of West Gulf Coastal Plains vegetation areas (ecoregions).

3. Soils.—The interrelationship of soils and flora has long fascinated ecologists (Warner 1926). Eastern versus western United States is clearly marked by a soil break (Carter 1931), and in the WGCP many plant communities are correlated directly with soils—e.g., blackland prairies, Weches Formation, and sandstone glades and outcrops. We surveyed the WGCP soil literature (Carter 1931; Godfrey et al. 1973; Steila 1993) to see if soils correlate with floristic ecoregional delineations.

4. Vertebrates.—Although our main focus is on the flora, we examined the literature on ecoregional distribution of vertebrates (except fish) in the WGCP in an attempt to see if animal distributions correlate with traditional plant ecoregions (Blair 1950; Webb 1950; McCarley 1959; Neck 1986; Gehlbach 1991; Wilkins 1992; Ward et al. 1994). Also, using lists of birds, reptiles, amphibians, and mammals from the WGCP, we plotted vertebrate distribution to see if there were any correlations with ecoregion.

RESULTS

1. Ecoregional mappers.—We confirmed the assessment of Webb (1950), Gleason and Cronquist (1964), and Hargrove and Luxmoore (1998). There have been dozens of WGCP ecoregional mappers, but, with one exception, there has been no floristic mapping based on quantitative data. Instead, we found that ecoregional mappers almost invariably base their maps on the presence or absence of one or a few "diagnostic" trees or a "suite" of trees, with little or no attention paid to herbaceous and understory species. None of the modern armament of statistical ecology and sampling (e.g., Mueller-Dombois & Ellenberg 1974; Peet et al. 1998) has been applied although it is beginning to be used in WGCP community ecology (Dale 1986; Turner et al. 1999). We also found little agreement among mappers.

Only Turner (1959) used quantitative methods and, not surprisingly, his results are unique (Fig. 2). Turner's method was relatively simple: he calculated "the percentage of species restricted to a given region ('endemic' species) and the percentage of species shared with other provinces ('shared' species). The percentage of restriction, expressed as that fraction of the total species known to occur in the province under consideration, was taken as the naturalness of the floral region" (Turner 1959:5 [see also Webb 1950 for comparable method using vertebrates]). He discovered that there were basically five regions in Texas that fit his criterion of 40% or higher for "endemism." Interestingly, he also found that attempts to delineate clearly distinct, but smaller, subdivisions resulted in such heterogeneous figures that these regions, on a floristic basis, would not be strictly comparable. Turner found that floristically the POSa, LLP, OPH, and Cross Timbers are similar and, therefore, he lumped them (his Appalachian) and separated from them the Prairie (his Campestrian) and South Texas Plains (his Tamaulipan) because they are different. This is a singular result among biogeographers, who invariably divide the WGCP into many ecoregions.

2. Floristics.—Using floristic and plant community lists from various areas within the POSa, OPH, and LLP regions, we compared floristic and community similarities and differences throughout the LLP, POSa, and OPH region of the WGCP. The result: all regions had greater than 90% of their flora in common. Virtually the same holds for communities. For example, pockets of prairie occur throughout the OPH, POSa, and LLP regions, bogs occur in all three

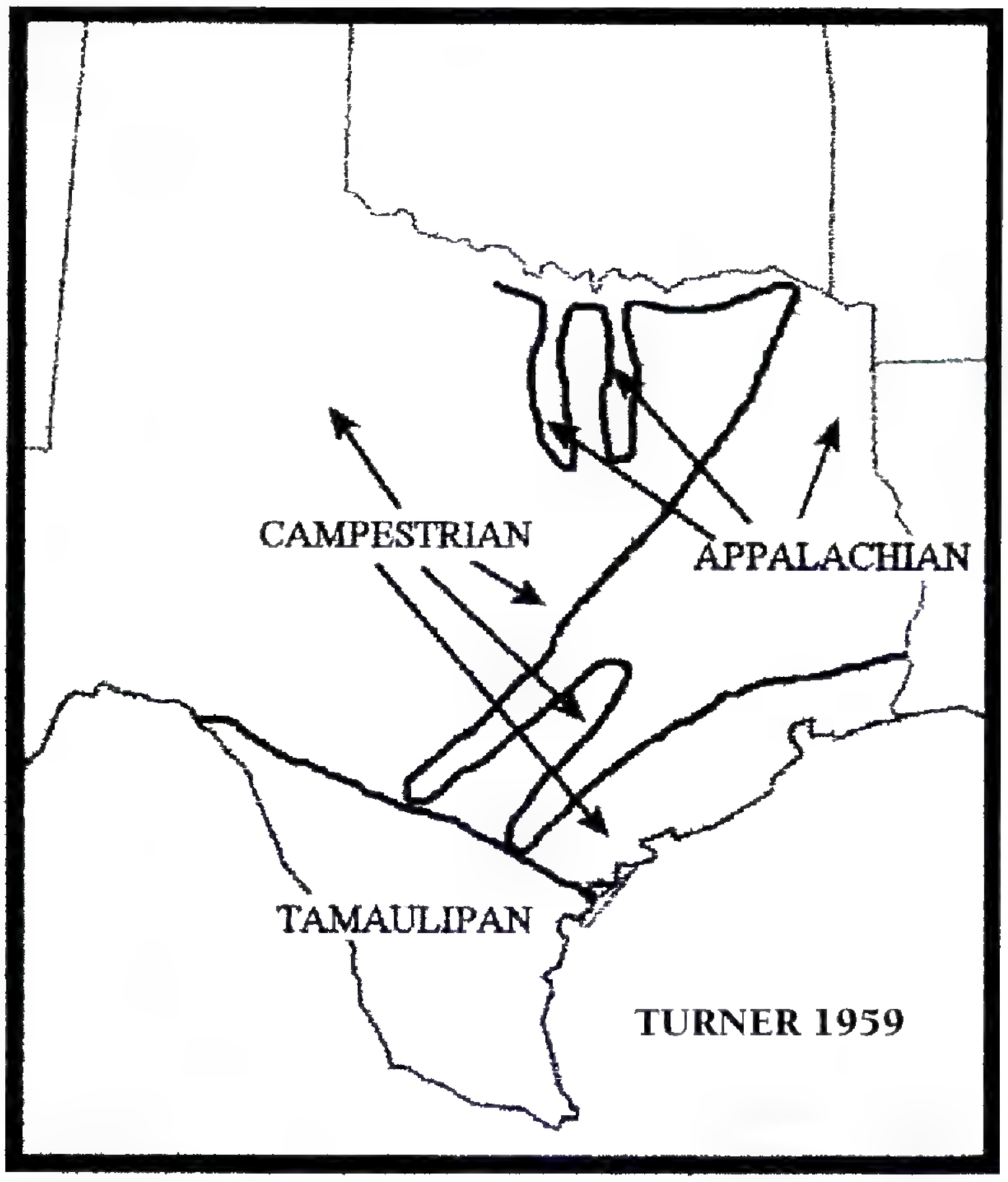


Fig. 2. B.L. Turner's (1959) Texas vegetation areas.

regions, notably in the LLP and POSa areas, hardwood-beech slopes are found in both LLP and OPH regions, baygalls are common in all three regions, grossarenic xeric sandylands and xeric oak woodlands are especially common in the POSa region but present in the other two regions as well, sandstone outcrops or barrens occur in the POSa and LLP regions, and so on. Since no one has collected the data to perform an analysis of species abundance, very little can be said about that parameter.

One of the predictions of biogeography (we assume) would be that different sections of the same ecoregion should be floristically more similar to each other than to different ecoregions. Biogeographers such as Kuchler (1964; see also Gleason & Cronquist 1964; Cronquist 1982; Takhtajan 1986) have placed states as distant as Maine, Michigan, and Texas in the same ecoregion or province (Oak-Hickory Forest, Appalachian Province). We compared the floristics between Kuchler's Oak-Hickory Forest in Texas (POSa ecoregion) and Oak-Hickory Forest in Missouri 300 miles away and the Oak-Hickory-Pine Forest (OPH ecoregion) in Mississippi 300 miles away. We found that the different ecoregions were more similar (Texas POSa and Mississippi OPH: 81% of species

in common) than areas within the "same" ecoregion (Texas POSa and Missouri POSa: 67% of species in common). We also compared the differences between Michigan and North Carolina and the POSa of east central Texas. Michigan and North Carolina are both 1000 miles from east central Texas, but Michigan is supposedly in the same province or ecoregion, while North Carolina is not. The result: Michigan had 44% and North Carolina had 75% of the species in common with Texas.

3. Soils.—A survey of the soil literature uncovered no overall soil/floristic correlations for the LLP, OPH, or the POSa ecoregions but instead a great interdigitation of soil types (largely Alfisols and Ultisols) throughout the region (Tharp 1952; Godfrey et al. 1973; Smeins & Diamond 1986). However, the prairie soils (both blackland and coastal) do fall out clearly along traditional floristic boundaries. On a broader note, Hargrove and Luxmoore (1998), using multivariate analysis of nine edaphic variables (including: elevation, soil, water, temperature, climate), produced a high resolution map of the United States. Overlaying this on traditional WGCP vegetation maps shows no correlations. The LLP, POSa, and OPH regions do not stand out individually but merge together into one general area.

4. Vertebrates.—Zoologists have long known that no correlation exists between vertebrates and the traditional floristic ecoregions. Instead, the prairie areas form a break between eastern and western species. Central Texas is a transition zone for vertebrates, but central Texas begins west of the POSa region (Webb 1950; Neck 1986; Gehlbach 1991; Wilkins 1992; Ward 1994). As far as vertebrates are concerned, the eastern WGCP as a whole is significant, not its components. Our survey of vertebrate distribution confirms the zoologists' contentions.

DISCUSSION

The most obvious finding of this study is that only one WGCP floristic ecoregion map was developed using quantitative methods and, parenthetically, it was subsequently ignored. All other schemes are subjective, the criticism made by Webb (1950), Gleason and Cronquist (1964), and Hargrove and Luxmoore (1998). There are no methodological descriptions, no quantitative data, no demarcation criteria, and no statistical analyses. Apparently, ecoregions are self-evident and impressionistic description is considered sufficient. The question Webb (1950:426) asked five decades ago is as pertinent today as it was then: "How different must the fauna and flora of two areas be before they are recognized as examples of different ecoregions?"

Only Turner (1959) attempted an answer, and he found that the eastern WGCP constituted a single floristic region. We have confirmed this finding: between 90% and 99% of species occurring in the LLP, OPH, and POSa regions also occur in the others, and the majority of plant communities are common to all three regions. When traveling from one region to another, the botanist does

not encounter a new flora, the zoologist a new fauna, and the ecologist a new set of plant and animal communities. What differences exist are not of kind but of degree. Sharp boundaries simply do not exist.

Many individuals have noted an east-west gradient between OPH and POSa regions. Tharp (1926:48) pointed out that *Quercus stellata* and *Q. marilandica* Muenchh. are often codominants with pine in the OPH ecoregion and that the transition to POSa "... merely means the gradual decrease of pine until it has disappeared." McCarley (1959:390) said: "The boundary between the pine-oak region and the oak-hickory region is nowhere sharply marked, but is characterized by a gradual decrease in pine and an increase in oaks and hickories." Wilson (1990:184) said: "At the western edge of the piney woods, the mixed pine-oak forest gave way to ... a hardwood forest similar in composition to the deciduous component of the mixed forest," and further, the pines disappear "from the forest leaving a mixed hardwood forest." Currie (1991), Nesom and Brown (1998) and Nesom et al. (1997) documented the loss of tree species diversity, not just pine, in the WGCP as one moves west. Although pockets of pines occur in the POSa region almost to Austin and Paris, Texas (Warner 1926; Wilson 1989), pines tend to drop out of the flora just before the true prairies are reached. Blair (1950) clearly had trouble separating the OPH and LLP regions from the POSa and spoke of an ecotone between them and the prairies farther west. Recent analysis of the distribution of *Pinus palustris* in east Texas does not support the simple story of savannas dominated by single species but rather tells a complex story involving the occurrence of mixed longleaf-shortleaf pine savannas not only on the periphery of the *Pinus palustris* range, but at its center (Evans 1997). Monk et al. (1990:77), in their study of so-called oak-hickory communities across the eastern United States, found that hickory was seldom, if ever, a dominant or codominant: "No real evidence was found for a regional oak-hickory forest." Dale and Ware (1999), commenting on this matter, pointed out that in contrast to these earlier findings, hickory may be a codominant in certain areas west of the Mississippi River.

Few question how the lines get on ecoregional maps—why a given line forms a polygon without internal polygons of other types. What is evident is that ecoregion delineations leave out all the messy detail; they are idealizations that actually describe very little of the area encircled. For example, at the macro-level the Takhtajan (1986) and Cronquist and Gleason (1964) descriptions of the Texas POSa region (their Appalachian and Eastern Deciduous Forest provinces) are so far out of the range of the "type" that they are simply not the same association of plants. At the micro-level, adjacent areas designated as different are not floristically different at all. As far as we have been able to ascertain, the LLP "ecoregion" is simply an autecological statement about the presettlement distribution of *Pinus palustris*. There is no unique LLP "ecoregion" flora with a substantial number of endemics and unique plant communities. The POSa

"ecoregion" is the western edge of the southeastern pine/oak forest and, as such, many species drop out; notably pines. But again there is no floristic break or large number of endemics or unique communities by which the POSa "ecoregion" can be described. The OPH "ecoregion" is similarly undifferentiated—aside from the absence of *Pinus palustris*, it is difficult to find anything that warrants setting it off as a separate region.

While the construction of ecoregional maps might seem to have little or no import, this is not entirely so. Ecoregions are the basis for deciding conservation priorities. For example, Diamond et al. (1997), Ricketts et al. (1999a, 1999b), Weakley et al. (1999), and Myers et al. (2000) all are concerned with priorities for conservation of rare species, endemic species, and rare habitat, and decisions about them are based on the concentration of rare species, endemics, and so on, which in turn is based on which map is selected: Ricketts et al. (1999a, 1999b) chose Omernick (1986), Weakley et al. (1998) chose Bailey et al. (1994), and Diamond et al. (1997) chose Gould (1962). Setting aside the almost insurmountable problems of how species numbers and their rareness are calculated for these ecoregions, the fact remains that size of area and its location make a lot of difference in deciding whether or not an ecoregion is an ecological "hot spot" or "cold spot." For example, Ricketts et al. (1999a) concluded that the OPH plus LLP ecoregions (their "Piney Woods Forests") had only 7 endemic plants and the POSa region (their "East Central Texas Forests") also had only 7 endemic plants. However, by combining the POSa, OPH, and LLP regions, we calculate that these three "regions" together have approximately 100 endemic or near-endemic plants, not 14!—thereby instantly changing the WGCP from an ecological cold spot to an ecological hot spot. A map that combines the POSa, LLP, and OPH regions makes for very different biogeography and conservation than one that divides them, and the decisions made by conservationists on the basis of one map may be very different from decisions made using another map.

We are not suggesting that the WGCP or that part of it we have examined in this paper is uniform. Quite the contrary. Previous biologists related something they were familiar with and observed, and we, like our predecessors, can see what was being referred to. If we are attentive, we can tell when we have entered the LLP region by the presence of *Pinus palustris*, and traveling west, we also note when pine vanishes and the landscape is dominated by oaks. We can see these changes because we have been conditioned to look for them and because they are there. We also have no doubt that in these different regions there are differences in species abundance. Thus, the absence of pines from the POSa region and the presence of pines in the OPH and LLP regions signals difference in canopy structure. But lacking in any of these ecoregional descriptions is hard data (floristic lists and abundance data) and statistical procedures and operations for determining when two samples are ecoregionally the "same" or "different." Instead, cultural idealizations and stereotypy substitute for concrete description and

analysis. Consequently, even if we wished to provide a brief summary description of any region inorder to recognize its most valuable or "true" features based on previous delineations would be to rely on idealized and stereotyped descriptions, and would be confounded by precisely what we are describing here.

It is premature to make any definitive statement on the WGCP ecoregions. However, on the basis of our experience and limited floristic sampling, we would say that there is certainly no reason to separate the LLP region from the OPH region. There is nothing revolutionary in this since about half of the ecoregion mappers have already lumped them. Our current thinking about the POSa region is that it is virtually identical floristically to the OPH and LLP regions minus some tree species. But even this is difficult to maintain because, in northern Texas, pine is a part of the POSa flora. Areas such as the Gus Engeling Wildlife Management Area (POSa) in Anderson County are identical edaphically and floristically to Woods County (OPH): POSa habitat simply exists in Wood County with pine on it (see Wilson 1990). This is also the case in such areas as the "Lost Pines" near Bastrop. In conclusion, we find Turner's (1959) analysis approximately what we envision.

APPENDIX

This is a survey of the biogeographers who have produced maps of the WGCP; they are reproduced so they can be understood and compared.

The literature describing and illustrating ecoregions was located by tracing bibliographical entries and by consulting Kuchler and McCormick (1965). Vegetation mapping of the WGCP did not begin in earnest until the twentieth century.

Several early botanists described WGCP vegetation but did not give maps. Without maps it is very difficult, if not impossible, to interpret ecoregion locations precisely; therefore, these descriptions are excluded from this review (e.g., Bray 1906; Warner 1926). Some authors present maps but add little to previous descriptions; these are also excluded from the present discussion (e.g., Allred & Mitchell 1955; McMahan et al. 1984). General accounts of early WGCP botanical research and descriptions of vegetation are given by Harper (1920), Tharp (1926), and Geiser (1948).

WGCP ecoregion terminology has never been standardized and any attempt to cross-index all usages would be almost impossible. We have, therefore, taken the liberty of standardizing it for this paper. Since we reproduce the maps, the reader need only see the relationship between various maps to judge similarities and differences.

The following abbreviations are used.

CPM = Coastal Prairie and Marsh Ecoregion
EGCP = East Gulf Coastal Plain
LLP = Longleaf Pine Ecoregion
OPH = Oak-Pine-Hickory Ecoregion
POSa = Post-Oak Savanna Ecoregion
PRA = Prairie Ecoregion
STP = South Texas Plains Ecoregion
WGCP = West Gulf Coastal Plain

We have redrawn all maps from the originals. This has been done to make them interpretable for present purposes. We have taken some liberties to clarify complicated maps. Scholars should consult original maps for detail and original terminology.

In this review—which is done chronologically—we are concerned mainly with geographical areas at and below the ecoregional level. Mapping at higher levels (region, province, subprovince) (Gleason & Cronquist 1964; Good 1974; Cronquist 1982; Takhtajan 1986) is not our concern, although,

since the "provinces" of Dice (1943), Takhtajan (1986), and Gleason and Cronquist (1964) in the WGCP are basically the same as ecoregions, we do discuss them.

Cooper (**1859**; see Stuckey 1978) developed one of the first province maps for North America (Fig. 3). He first described the distribution of tree species in North America and, while performing no statistical analysis, he recognized that different areas had d fferent combinations of species not found in other regions. His map, not dissimilar from that of Takhtajan (1986) and Gleason and Cronquist (1964), was still being reproduced almost a century later (Dayton 1949). He divided North America into provinces and regions. Two provinces interest us: the Appalachian (eastern wooded) and the Campestrian (prairie). We have separated these by a heavy line. He divided each into five regions (we show only four for the Campestrian). The pattern later to be found in many ecoregion and province maps is clearly evident here.

Transeau (**1903**; see also Stuckey & Reese 1981; Delcourt & Delcourt 2000), following in the footsteps of Sargent (1881), produced a simple map of North American vegetation (Fig. 4). His few vegetation types are of interest only in that he included the Cross Timbers and POSa regions in the eastern deciduous forest type and separated the coniferous forest type (what later would become known as the LLP ecoregion).

Harshberger (**1911**) produced perhaps the first widely recognized phytogeographical map of North America, according to which the Atlantic-Gulf Coastal region encompasses most of east Texas and west Louisiana (Fig. 5). To the west of the Atlantic-Gulf Coastal region, Harshberger showed what he called the Ozark area of the Alleghenian-Ozark district, which today would be called the POSa and Cross Timbers ecoregions (POSa on map). Note that the area designated extends well north of Texas. Also note that south and west of this "Ozark area" is a PRA region as well as several other vaguely described regions that extend to the Texas coast. The southernmost, his "Gulf region of the Mexican phytogeographic province," would be our STP. But the others do not fol ow current usage. The western-most is his "Edwards Plateau forest, meeting ground for species of Atlantic, Rocky Mountain and Mexican forests" (EP on map). The center area is nis "Transition Prairie Forest district, comprising the oak openings" (TRAN on map). This region is a phytogeographic southern disjunct from Wisconsin, Iowa, and Illinois. The final region is his "Texas cross timber and coastal plain belt of heavy live oak with prairies sandwiched between." This today constitutes part of the CPM ecoregion but extends farther inland. Harshberger's use of "cross timber" here is confusing to the modern biogeographer. Also note that the limits of longleaf pine (and many other trees) are shown on his original map but that no longleaf pine ecoregion is recognized. But the salient features of the Harshberger map are that east Texas floristically is firmly joined to the Gulf and Atlantic Coastal plains, and tne POSs region is clearly recognized. There are several reprints of Harshberger (1911) but with black and white maps. These are difficult to interpret, and only the colored map of the first edition is satisfactory.

Shreve (**1917**) virtually established the modern WGCP pattern (Fig. 6). He distinguished three WGCP forest regions. The POSa region extends unbroken from south Texas to Michigan, the LLP region extends from southeastern Texas to Florida and North Carolina, and the OPH region extends from Texas to Virginia. This pattern, as will be seen, was followed with very little modification by such influential biogeographers as Braun (1950) and Kuchler (1964). Shreve's original map is in color and cannot be interpreted from black and white reproductions of which there are many.

Shantz and Zon (**1924**), in their widely reproduced map, added essentially nothing to Shreve (Fig. 7). The Shantz and Zon map has been widely reprinted, sometimes with minor modificat ons (Fenneman 1938; Barrett 1962; Fowells 1965).

Tharp's (**1926**) interest was regional (Fig. 8). He mapped Texas east of the 98th Meridian and did extensive field work throughout east Texas. He provided extensive descriptions of the vegetation regions. His captionless map (his plate III) is confusing, and the text requires careful study for complete interpretation. But his map is the basic pattern that is familiar today: a LLP region in southeast Texas, a coastal region, an OPH region to the north and west of the LLP region, and a

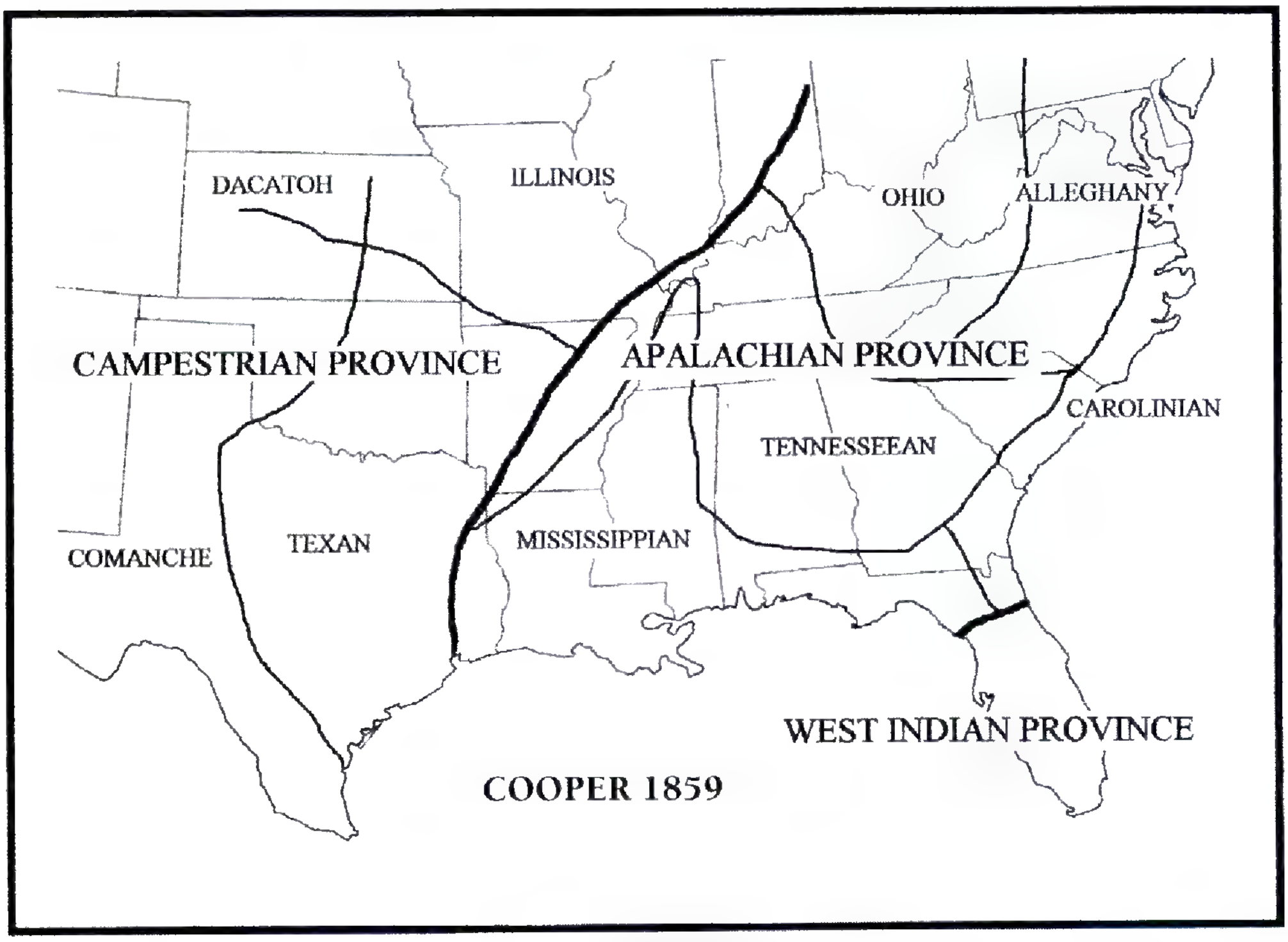


FIG. 3. Vegetation areas according to Cooper (1859).

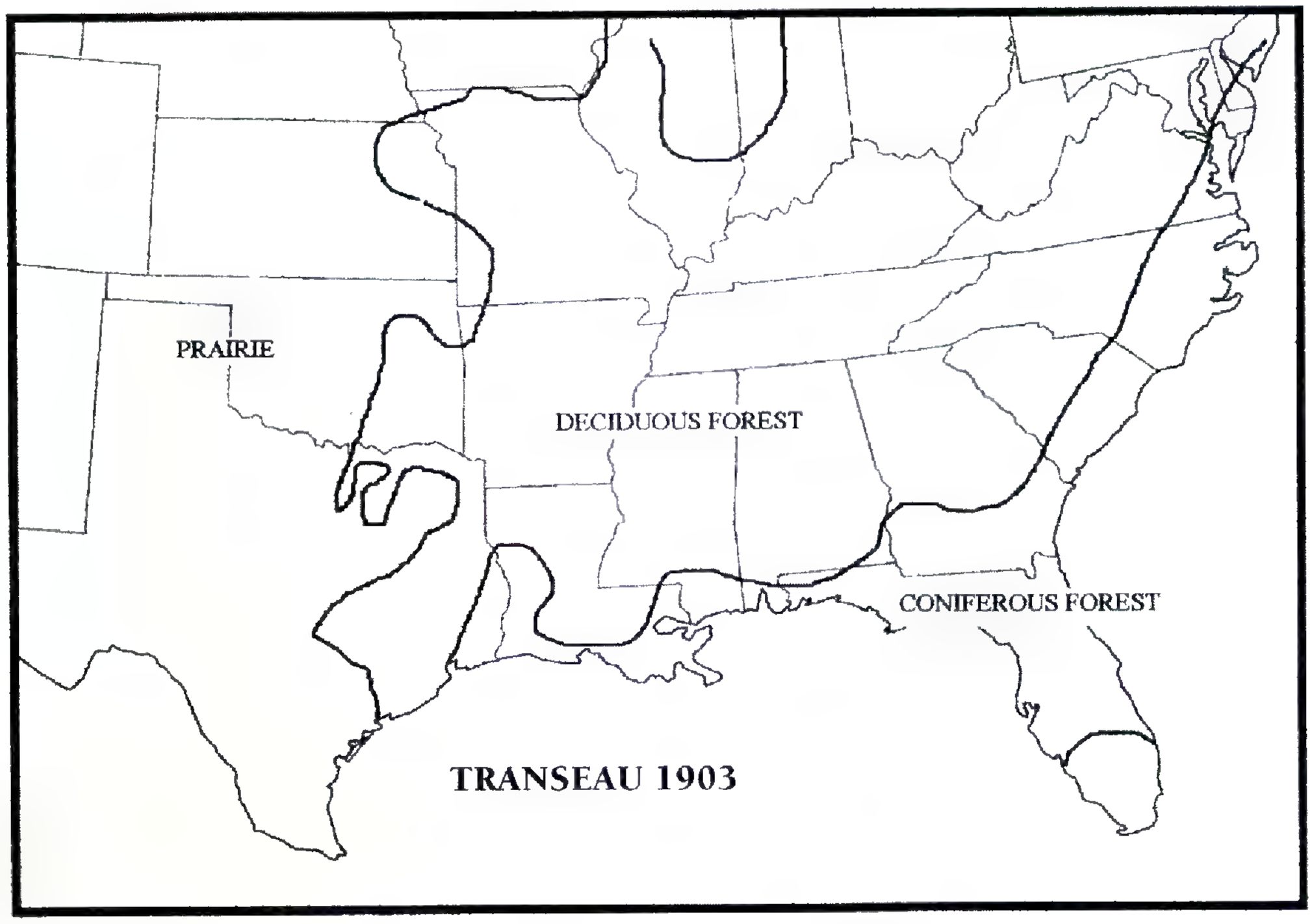


FIG. 4. Vegetation areas according to Transeau (1903).

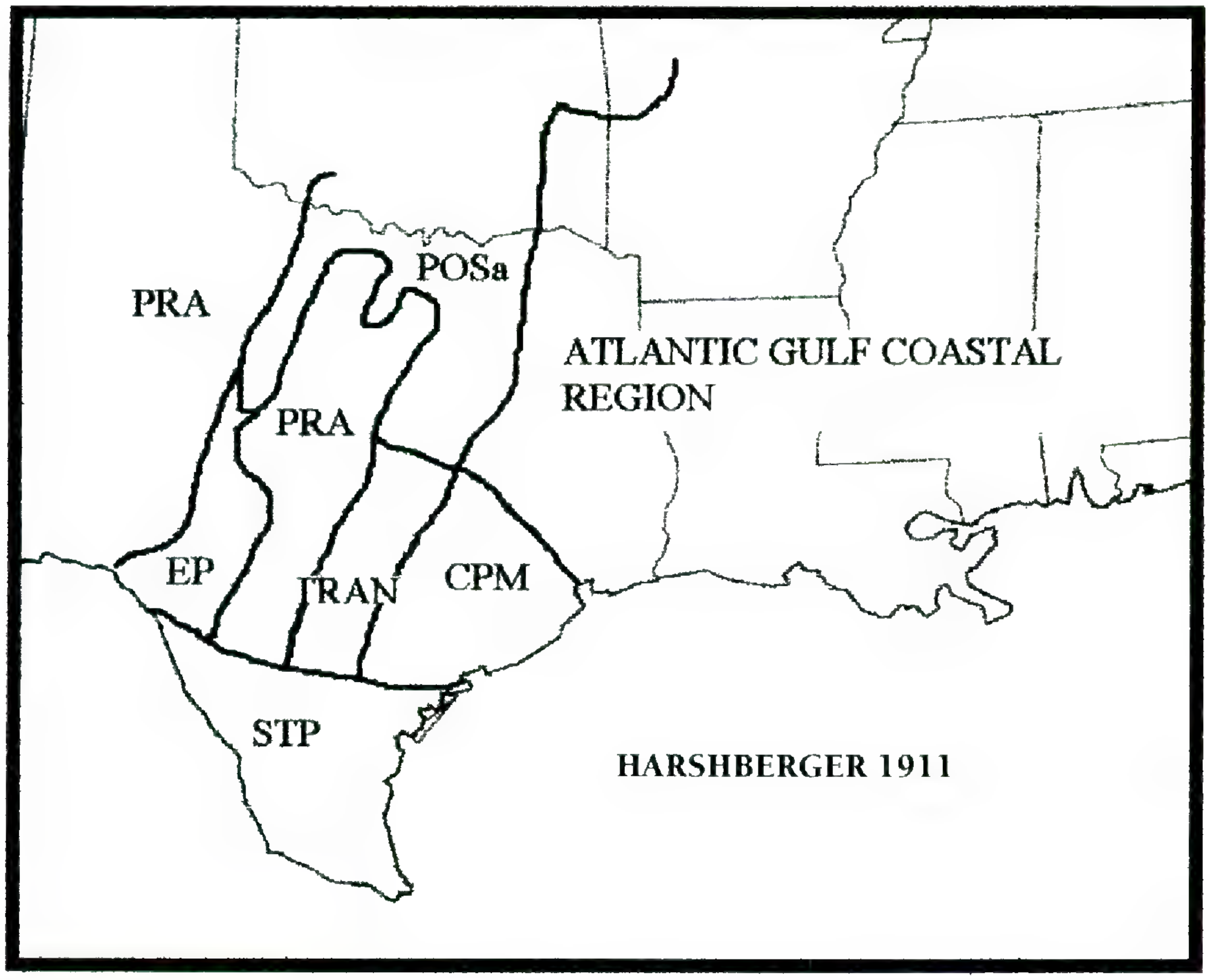


Fig. 5. Vegetation areas according to Harshberger (1911).

POSa region to the west of the OPH region. Tharp divided the POSa region into two areas. To the north, prairies are not common but to the south is an "oak-prairie mictium," that is, a combination of POSa and prairie southwest of the Brazos River. Later biogeographers showed this area as POSa with islands of prairie in it (e.g., Gould 1962; Diamond & Smeins 1988).

Carter (1931), the chief soil scientist for the Texas Agricultural Experiment Station, in his survey of the soils of Texas, produced a vegetation map for the whole state (Fig. 9). The accompanying soil map, while not matching the vegetation patterns precisely, does delineate the distribution of "main areas of deep sands" that correspond closely with the POSa region. Descriptions of the regions are given in his text.

Fenneman (1938) produced a slightly modified Shantz and Zon (1924) map (not reproduced here). He filled in the non-forested areas along the coast of Louisiana and Texas that they left blank. A modified version of this map is in Bonnicksen (2000).

Tharp (1939) refined his regional vegetational map (Fig. 10). In this version, the lines that were tentative in 1926 are bold. The WGCP is virtually identical to that given by Carter (1931), and any comparison of Tharp's map to that of Gould twenty years later leaves no doubt about influences. Tharp's brief descriptions of the vegetational regions are often folksy but never dull. Tharp's map was used by Wynd (1944).

Dice's (1943, 1968) "biotic provinces" are at a descriptive level above the ecoregion (Fig. 11). In this scheme, Dice divided east Texas into two regions: the Austroriparian and the Texan. The Austroriparian encompasses basically the entire Atlantic and Gulf Coastal Plain (OPH and LLP). The

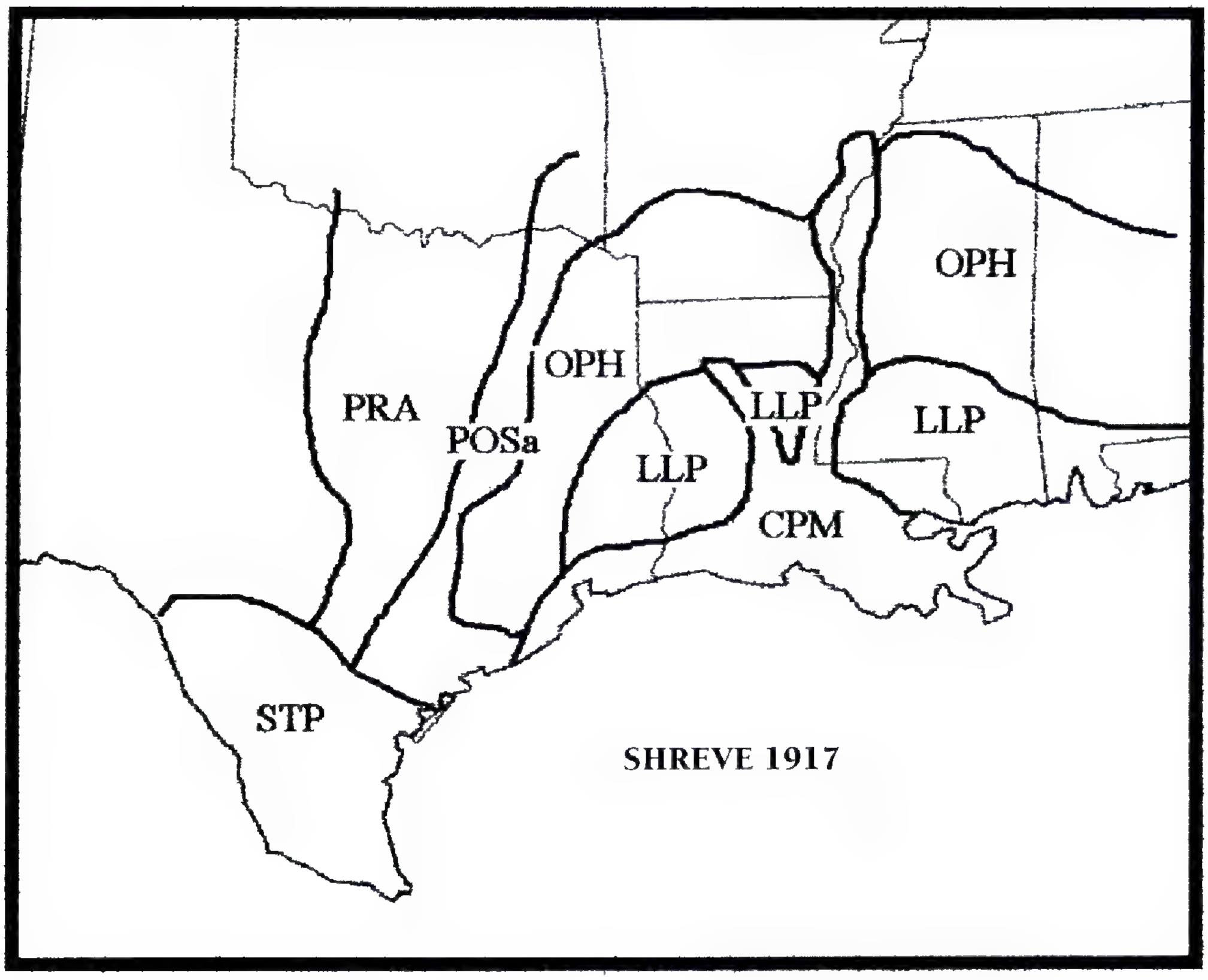


Fig. 6. Vegetation areas according to Shreve (1917).

Texan takes in the POSa as well as the prairies and cross timbers regions, and extends from central coastal Texas to northern Oklahoma. Blair (1950) followed Dice in his description of the east Texas biotic provinces but added nothing.

Braun's (1950) classic work on eastern forests adds little to our knowledge of the WGCP region (Fig. 12). Her map of "Forest Regions" is essentially identical to that of Shantz and Zon (1924) with only minor boundary shifts. She kept the three "regions" format: LLP, OPH, and POSa. While Braun sampled vegetation widely across the east, and produced tables of percent composition from many sites, but none from the WGCP, she did not statistically compare regions, but left that to her successors (e.g., Delcourt & Delcourt 2000).

Tharp's (1952) final map (not reproduced here) of the vegetation regions represents revisions and refinements of maps in his 1926 and 1939 publications. The greater detail is based on a decade of additional field experience, but the refinements for the WGCP are relatively minor and add little to his earlier work. Consequently, we do not present a separate map; however, it should be noted that his brief descriptions of each vegetation region are succinct and clear.

Turner (1959) is unique among WGCP authors in that ne used quantitative methods to determine what he calls "floral provinces" (Fig. 2). We have discussed his work in the first part of this paper.

Gould's (1962) map is clearly influenced by Carter's (1931) and Tharp's (1926, 1939, 1952) work (Fig. 13). The map and slight variants have been used extensively (e.g., Correll & Johnston 1970; McMahan et al. 1984; Hatch et al. 1990; Diggs et al. 1999) and one version of it presents subregions (e.g. LBJ School of Public Relations 1978; Diamond et al. 1987; Telfair 1999).

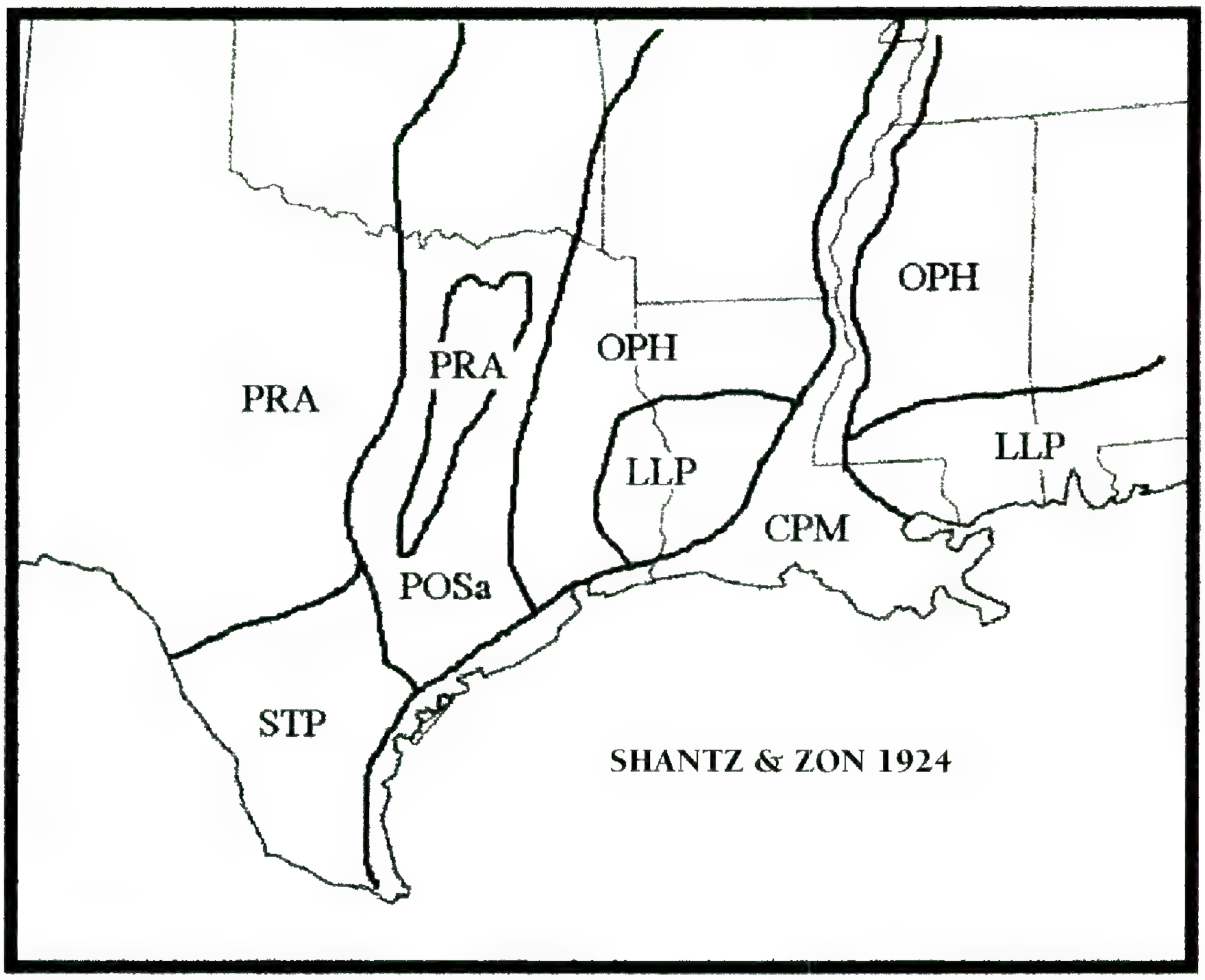


Fig. 7. Vegetation areas according to Shantz and Zon (1924).

Gleason and Cronquist (1964) detailed ten floristic provinces of North America, four of which occur in the WGCP (Fig. 14). What is of interest to us in this map is the association of the POSa region, notably regions as far south as Guadalupe County in Texas, with regions as far north as Maine, southern Ontario, Michigan, and Minnesota: this entire area Gleason and Cronquist called the Eastern Deciduous Forest Province. The floristic similarity among extreme parts of this large region is very small indeed. At the same time, their Coastal Plain Province is nothing more than the traditional Atlantic and Gulf Coastal Plain that extends from east Texas to Florida and north to Virginia—a much more floristically homogeneous region than the Eastern Deciduous Forest Province. Takhtajan (1986) produced a province map of North America virtually identical to that of Gleason and Cronquist (1964), which has been reproduced (Thorne 1993) (Fig. 15).

Kuchler's (1964) map, "Potential Natural Vegetation of the Conterminous United States," has become the "central dogma" of North American biogeographers upon which all other maps are judged (Fig. 16). It is widely cited and used (e.g., Martin et al. 1993). The Kuchler map presents no novelties for the WGCP; it is virtually identical with those of Shantz and Zon (1924) and Braun (1950).

Mahler (1981) presented an interesting variation on the Gould (1962) map (Fig. 17). Apparently following the lead of McLeod (1971), he designated not a LLP ecoregion in southeast Texas but a Beech-Magnolia-Pine-Oak-Sweet Gum (Big Thicket) region overlying most of the traditional LLP ecoregion. Why Mahler (1981) chose this course is not clear, but it underlines the fact that other ecoregion descriptions can be considered.

Omernik's (1986) was the first ecoregion map where ecoregions no longer straddle the Mississippi River (Fig. 18). Additionally, Omernik did not divide the pineywoods region into two

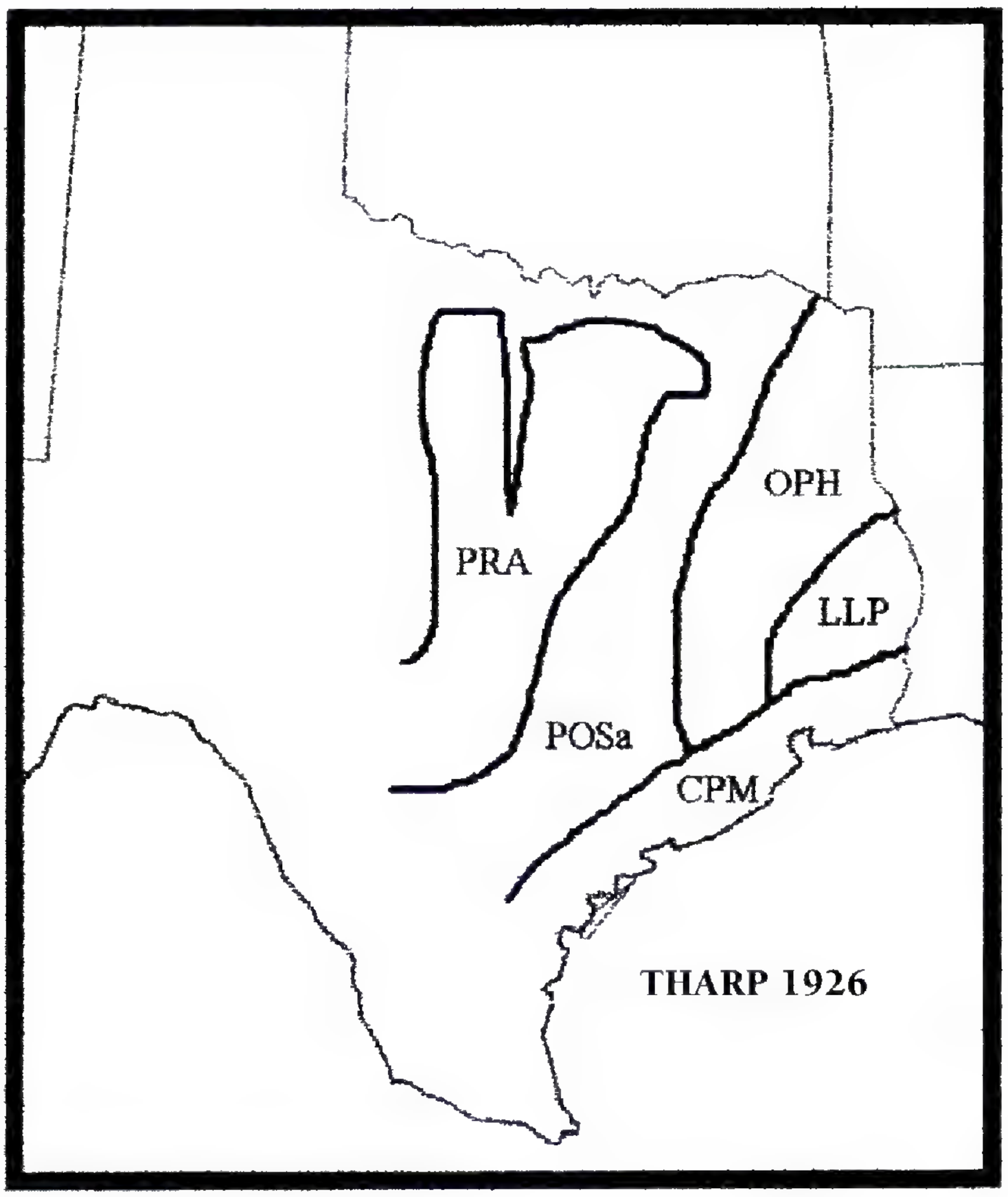


Fig. 8. Vegetation areas according to Tharp (1926).

ecoregions (OPH and LLP) but like Gould (1962) kept them together. Otherwise, the familiar pattern is maintained. But what is interesting here is that the LLP region is not uniquely distinguished in either the WGCP or EGCP. How Omernik distinguished EGCP ecoregions from WGCP ecoregions is not evident since his brief descriptions are virtually of no help.

Greller (1988) produced a map that he claims is based on Braun (1950) but which shows no closer relation to hers than it does to the maps of Shantz and Zon (1924) or Kuchler (1964) (Fig. 19). What is unique about Greller's map is that it combines the POSa and the OPH regions with no explanation given (but see Turner 1959). Greller did, however, retain the other traditional ecoregion features, such as the LLP ecoregion.

Barbour and Christensen (1993) presented a relatively simplified vegetational map of North America (Fig. 20). We find in it the traditional LLP and OPH regions, but the POSa region has been separated and joined into a vast region stretching from the Gulf of Mexico to Canada. This region is described as "tallgrass prairie, including the prairie peninsula and oak savanna ecotone with the eastern deciduous forest" (1993:98). Treating the POSa region as an "ecotone" and including it in the prairie ecoregion has been commented on (Gehlbach 1991) and is reminiscent of Dice's (1943, 1968) and Blair's (1950) "Texan" biotic province.

Bailey et al. (1980, 1994, see also DeGraaf et al. 1988; McNab & Avers 1994) resurrected the old Texan biotic province of Dice (1942, 1968) and Blair (1950), and then divided it into four subregions (Fig. 21). This ecoregion ("province" and "ecoregion" are apparently synonyms here) extends

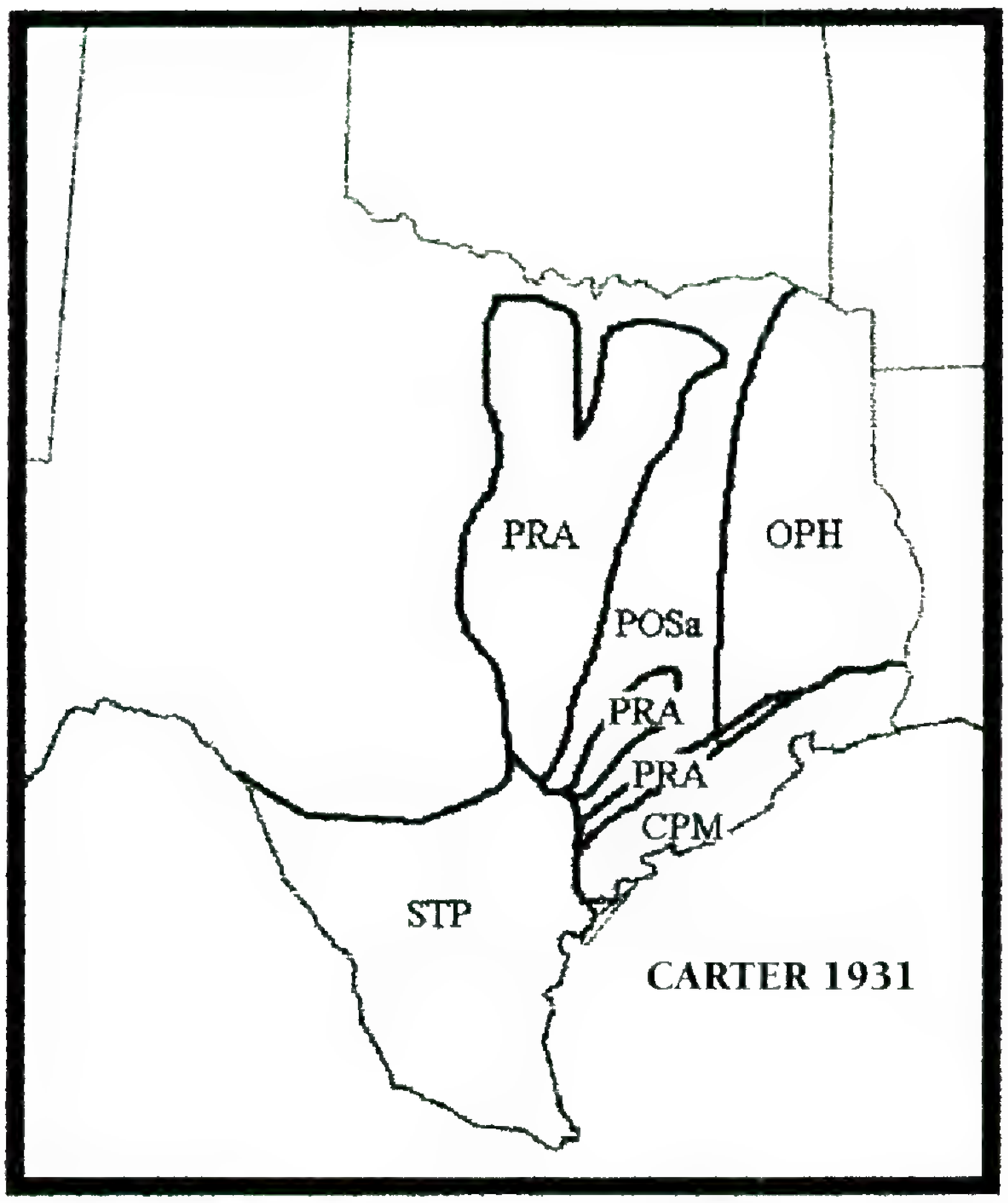


Fig. 9. Vegetation areas according to Carter (1931).

from the Texas coast to northern Oklahoma. The eastern most part is separated as the "Oak woods and prairies subregion" (255C), which is virtually identical to the POSa region of previous writers except that it includes several major sections of the prairie region of east Texas, such as Fayette Prairie. This makes the Bailey "Oak woods and prairies subregion" non-comparable with the maps of most other biogeographers. Like many before them Bailey et al. (1994) divided the remainder of the WGCP in two regions. The southern one corresponds with the LLP, and the northern one corresponds to OPH. At the subregional level, nowever, they separated botn the OPH and the LLP regions west of the Mississippi River from the OPH and LLP regions east of the Mississippi River. What distinguishes these areas, aside from geographical location, is not disclosed, and the McNab and Avers (1994) descriptions do not help. It should be further noted that the Bailey (1994) text and the McNab and Avers (1994) descriptive material are peppered with factual mistakes, something not found in previous biogeographic descriptions.

The map of **Keys et al. (1995)** and **Bailey (1994)** are virtually identical. Because the Key et al. (1995) map is more detailed, the western boundary of the WGCP is more easily distinguished (Fig. 22). The northern POSa region may have been included in the OPH region while the southern POSa may have been included with the Prairies sections. Bailey et al. (1994) may have done this also, but that map is cruder and harder to decipher: they may have put the entire POSa region in with the prairie group. The Keys et al. (1995) map divides ecoregions into dozens of "nested" subsections that are not readily distinguishable on the basis of their descriptions (nor are they distinguished by regional ecologists and botanists). Also, the Keys et al. (1995) map is clearly based on a poor knowledge of the WGCP. The text presents several factual mistakes.

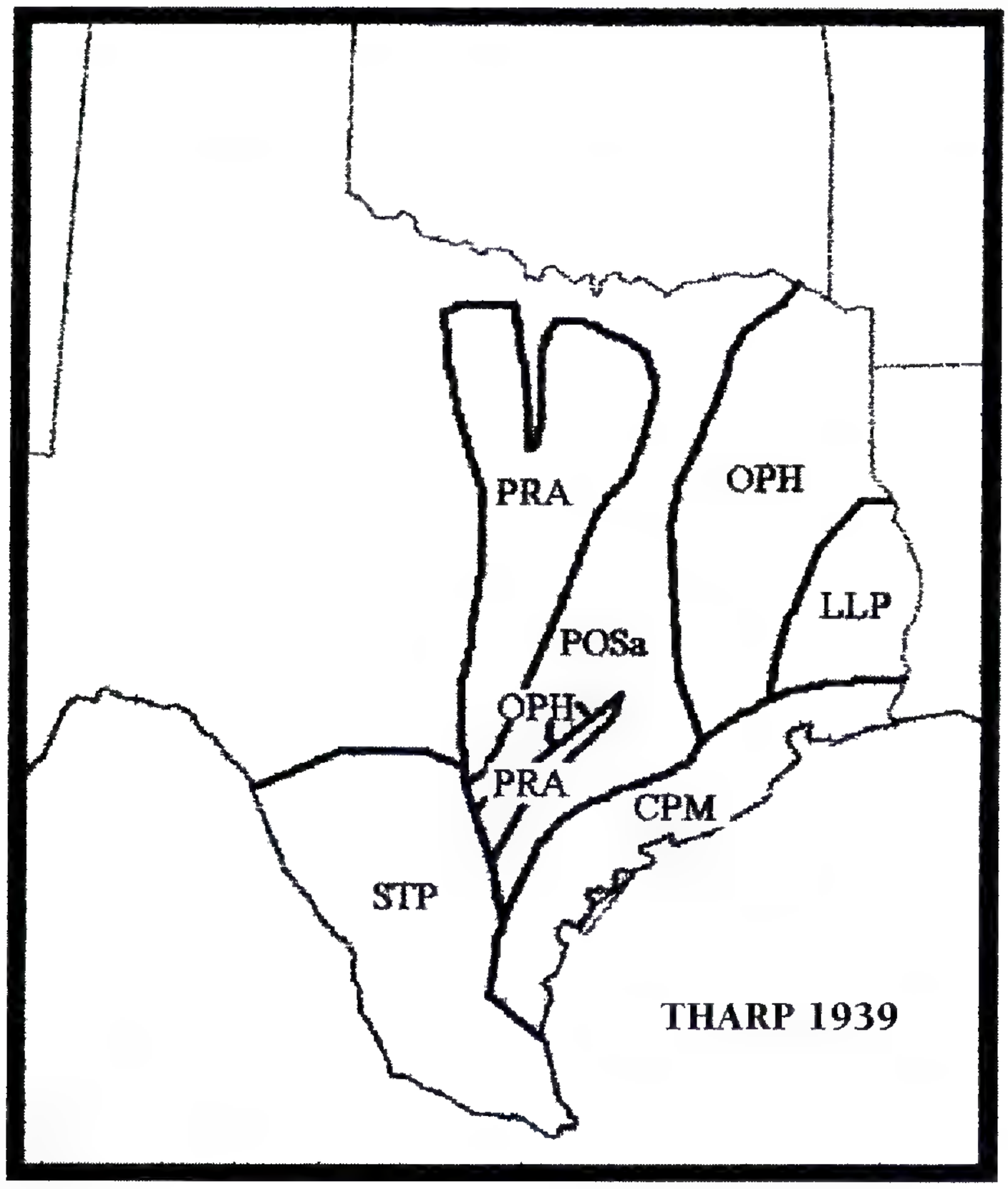


Fig. 10. Vegetation areas according to Tharp (1939).

The Nature Conservancy (**Weakley et al. 1998**; Turner et al. 1999) relies heavily on Keys et al.(1995) and Bailey et al.(1994), and it is through the Nature Conservancy maps that it is possible to detail precisely where the Keys et al. (1995) ecoregions, provinces, sections, and subsections are (Fig. 23). The POSa region has disappeared as a region. In the north, it is divided between the prairies region and the "Upper West Gulf Plain" region. In the south, the "West Gulf Coastal Plain" region is basically coterminous with Longleaf pine. This new terminology should lead to confusion.

Ricketts et al. (**1999a, 1999b**) divided North America into two phytogeographic levels. The first is ten Major Habitat Types in which most of the WGCP is lumped with the LLP region and not with the OPH region of the east, and the POSa region is lumped with the majority of the east but is geographically separated from it. At the finer level, in the WGCP the traditional LLP and OPH regions are lumped into the "pineywoods region;" whereas in the EGCP, they are inexplicably kept separate. The POSa region is separated from the "pineywoods." In the EGCP, while the traditional LLP and OPH regions are recognized, they are ignored in the WGCP. The descriptive sections of this account are replete with factual mistakes, and it is clear that part of the problem is a heavy reliance on Bailey et al. (1994). Ricketts et al. (1999a, 1999b) apparently believe that longleaf pine occurs over the entire "pineywoods" region. Since the Ricketts et al. maps of the WGCP are identical with Omernik's map, the reader is referred to that map for detail.

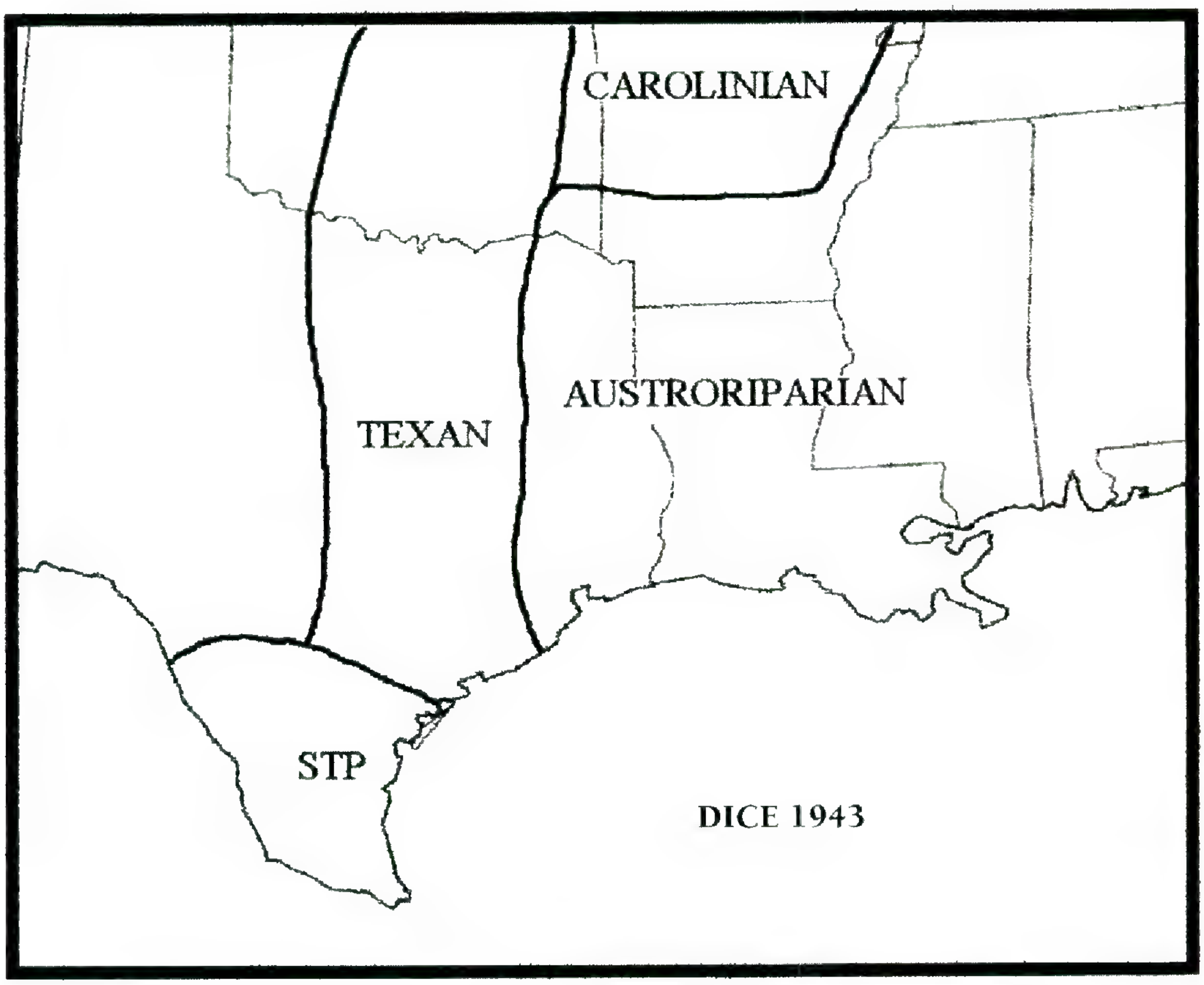


FIG. 11. Vegetation areas according to Dice 1943, 1968).

CONCLUSIONS

In summary, there has been relatively little evolution of the "ecoregion" maps of the WGCP over the 20th century. The patterns, but not the precise boundaries, found in the earliest maps are found in the later ones. The main questions appear to be whether or not to join the WGCP with the EGCP, whether or not to join the LLP region with the OPH region, and what to do with the POSa region? Should the latter be a part of a mega-region stretching from south Texas to Michigan? Should it be combined with the prairie region to the west, should it be kept separate from all other regions, or should it be cut in half and part of it put with the prairies and part with the OPH region? About half of the mappers recognize an LLP ecoregion, while the rest do not. It would appear that botanists who have constructed floras or distribution maps do not recognize a separate LLP ecoregion, presumably because the vegetational distinctiveness is either minor or virtually nonexistent (Correll & Johnston 1970; Gould 1975; Vines 1977; Nixon 1985; Hatch et al. 1990; Nixon & Kell 1993). Turner (1959) is the prime example of this. It is mainly ecologists who distinguish a separate LLP region.

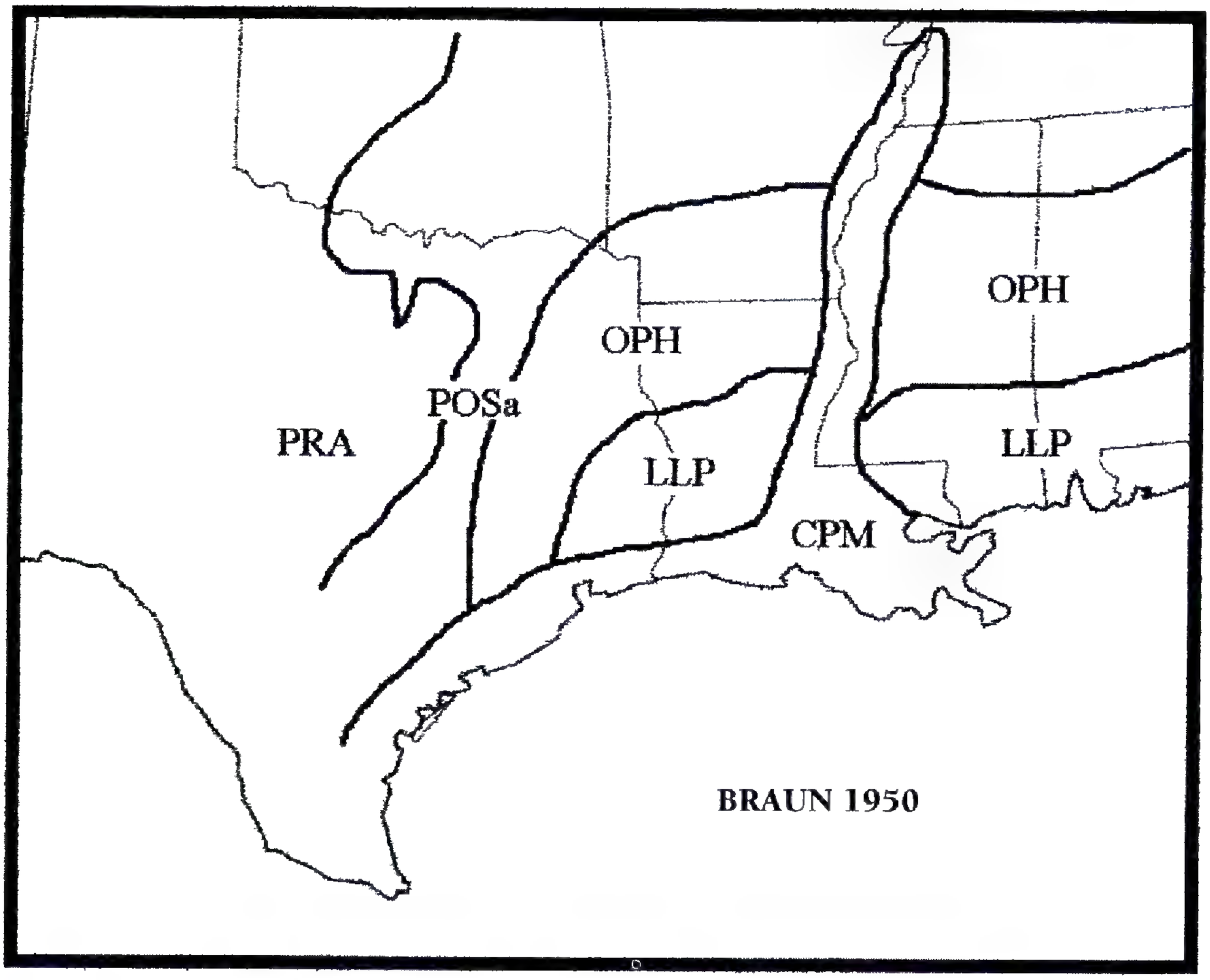


Fig. 12. Vegetation areas according to Braun (1950).

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Guy Nesom commented on several versions of the manuscript and brought B.L. Turner's ecoregion work to our attention. Billie Turner reviewed an earlier version of the manuscript and made many useful comments. L.M. Hardy aided with the maps.

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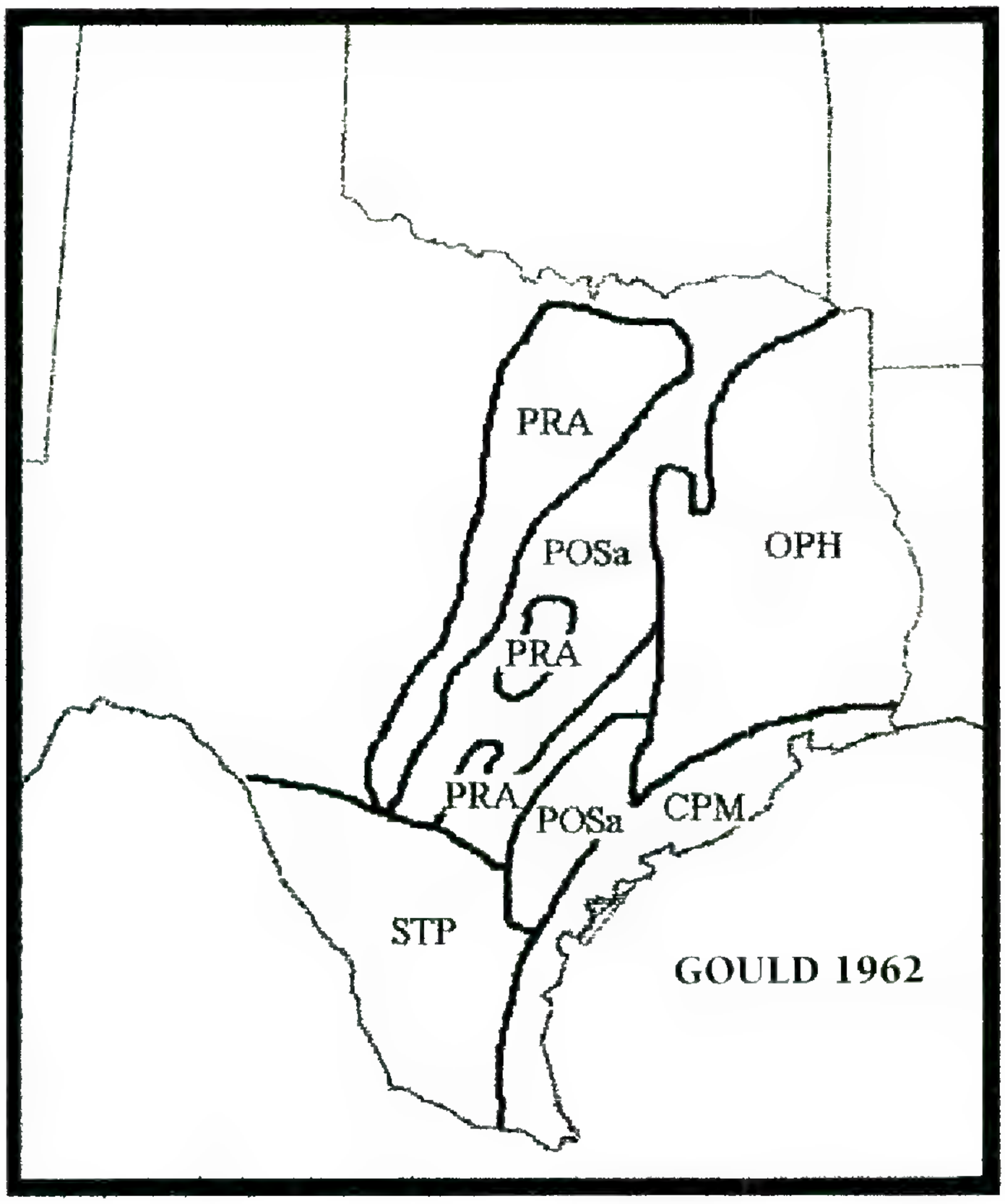


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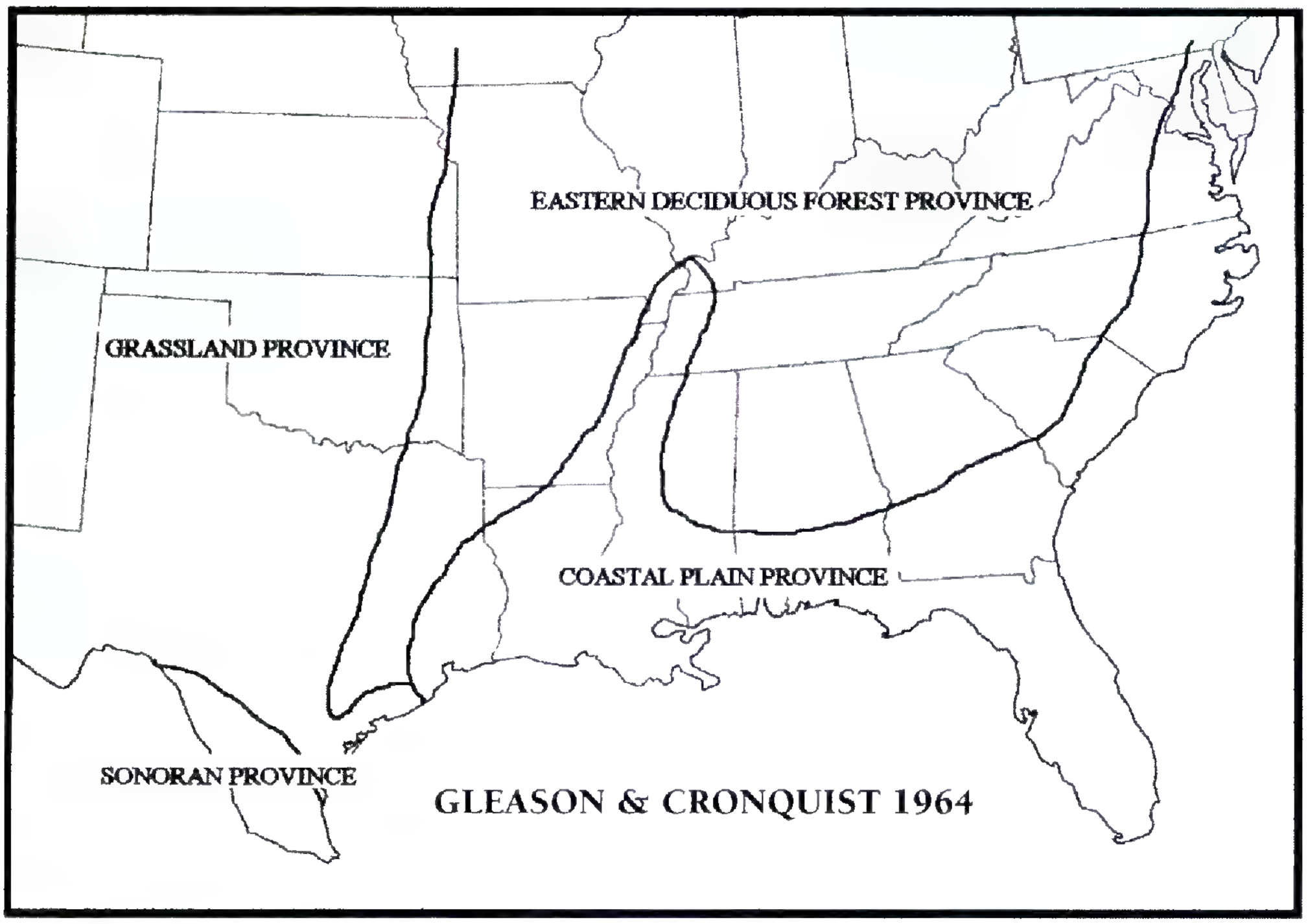


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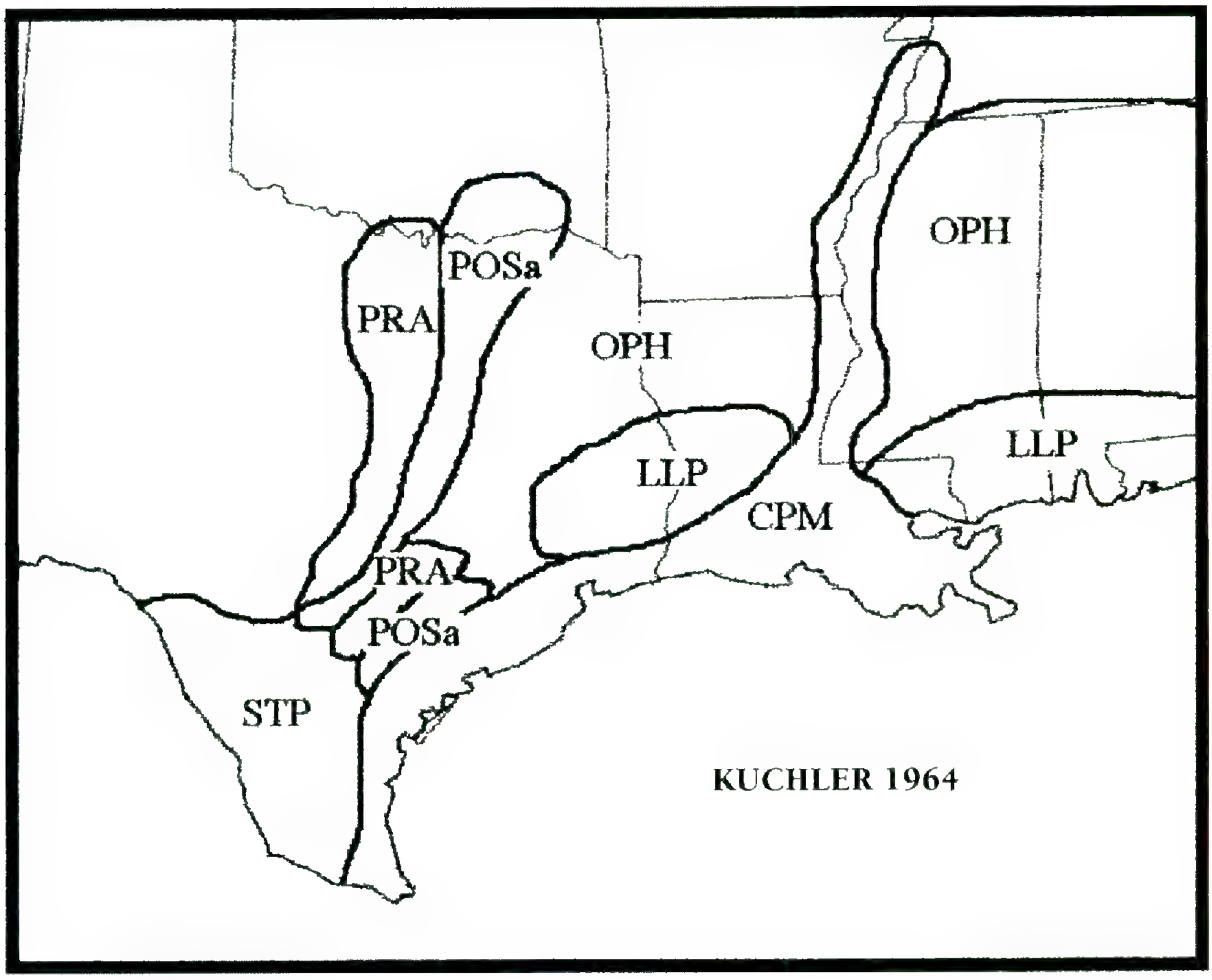


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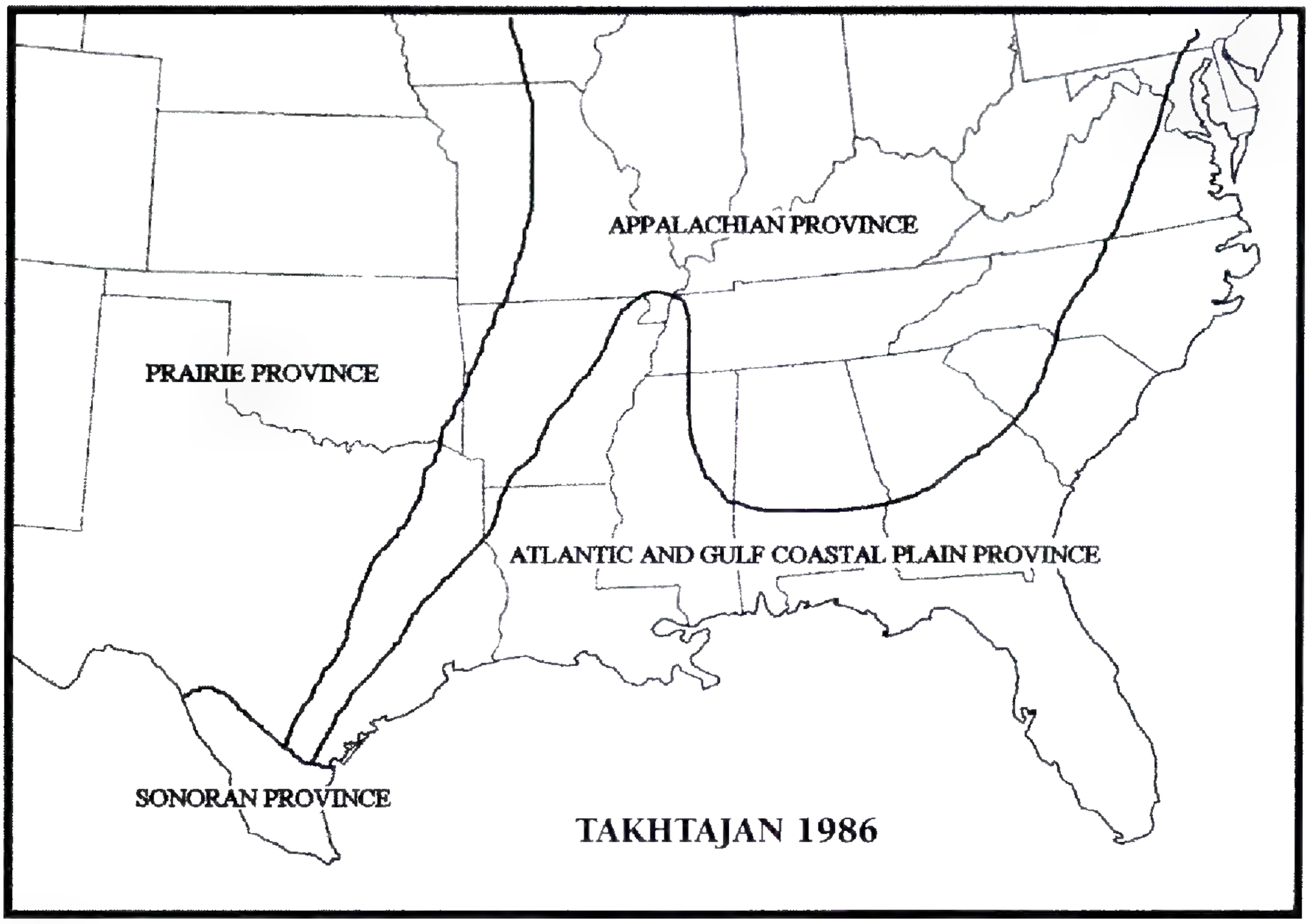


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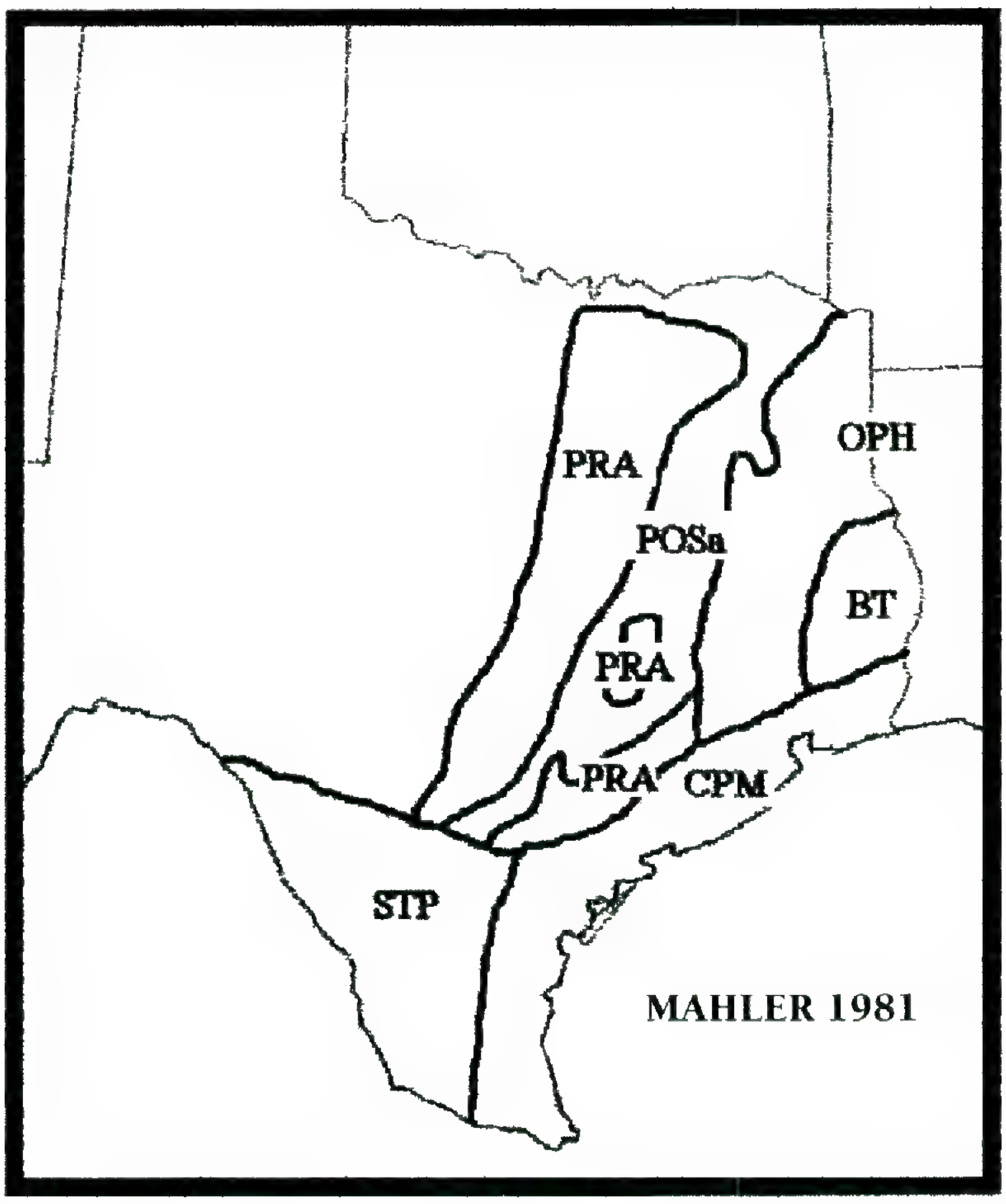


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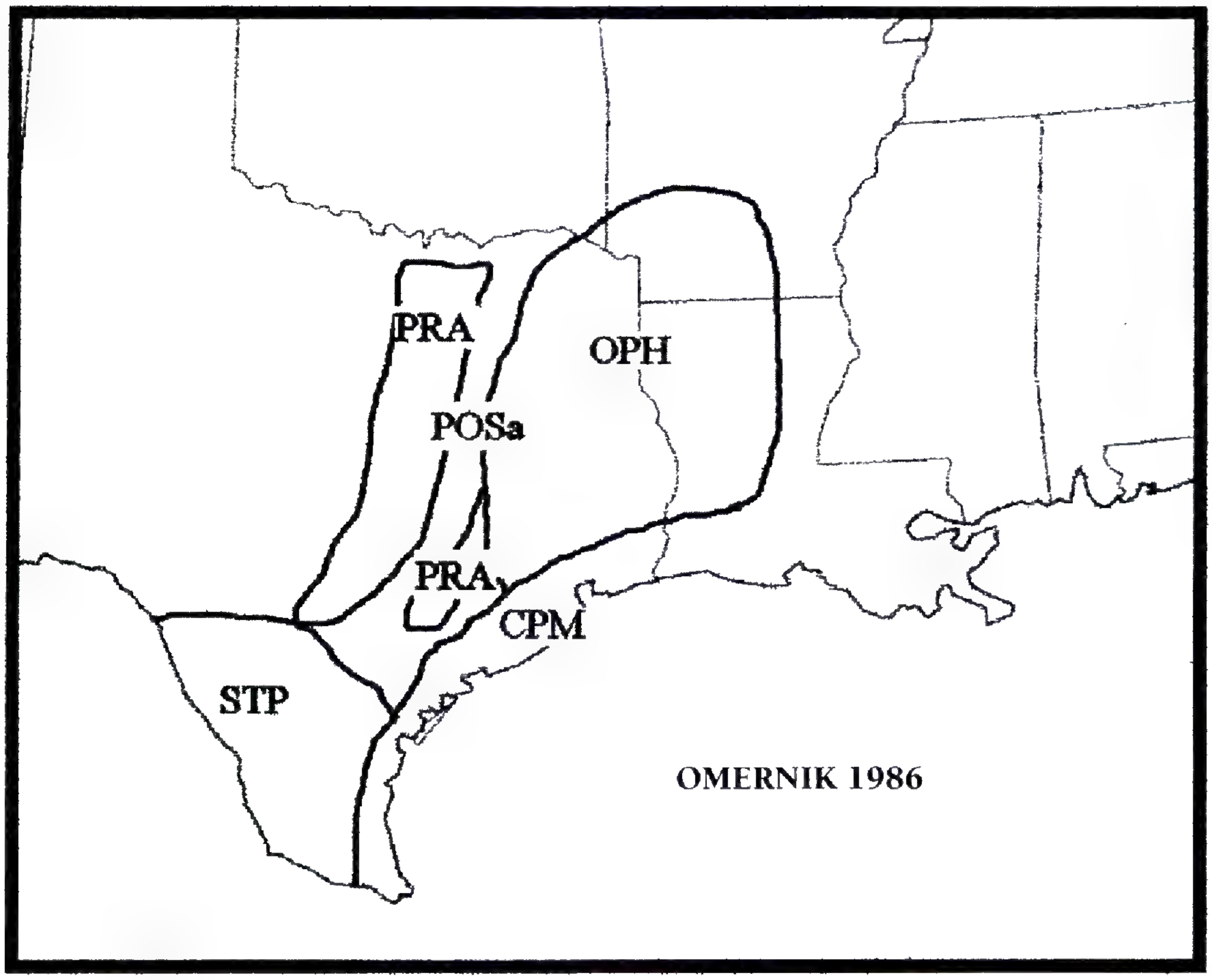


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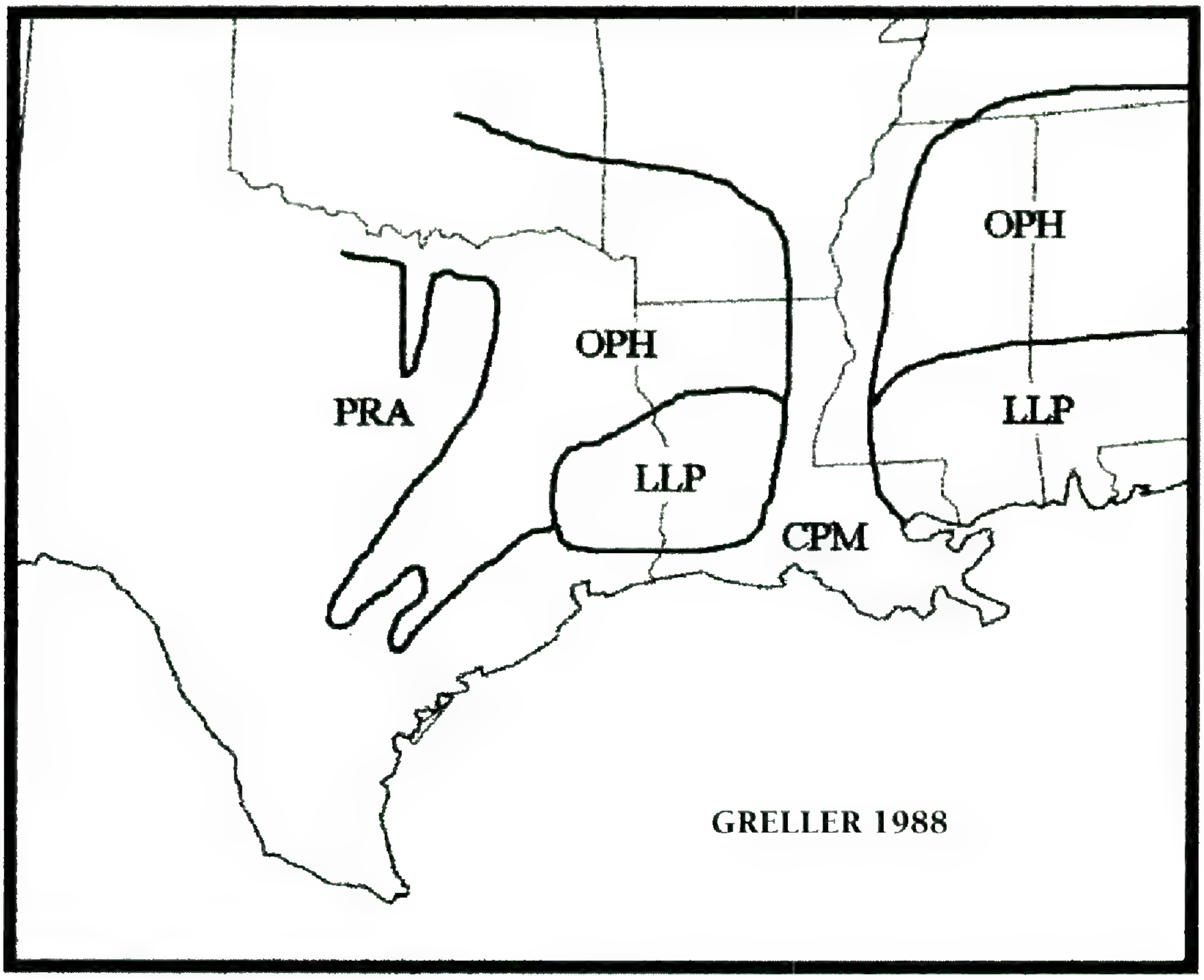


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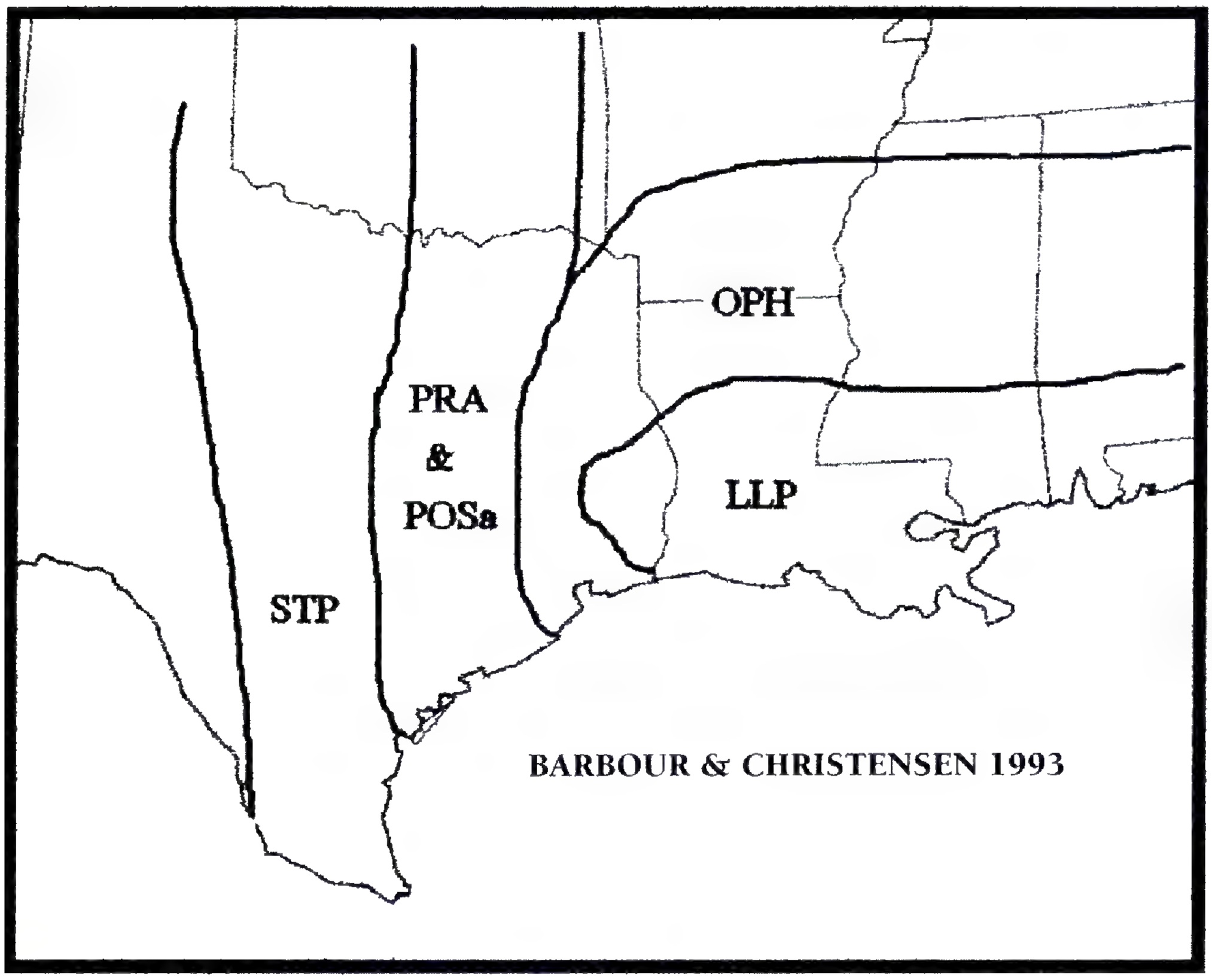


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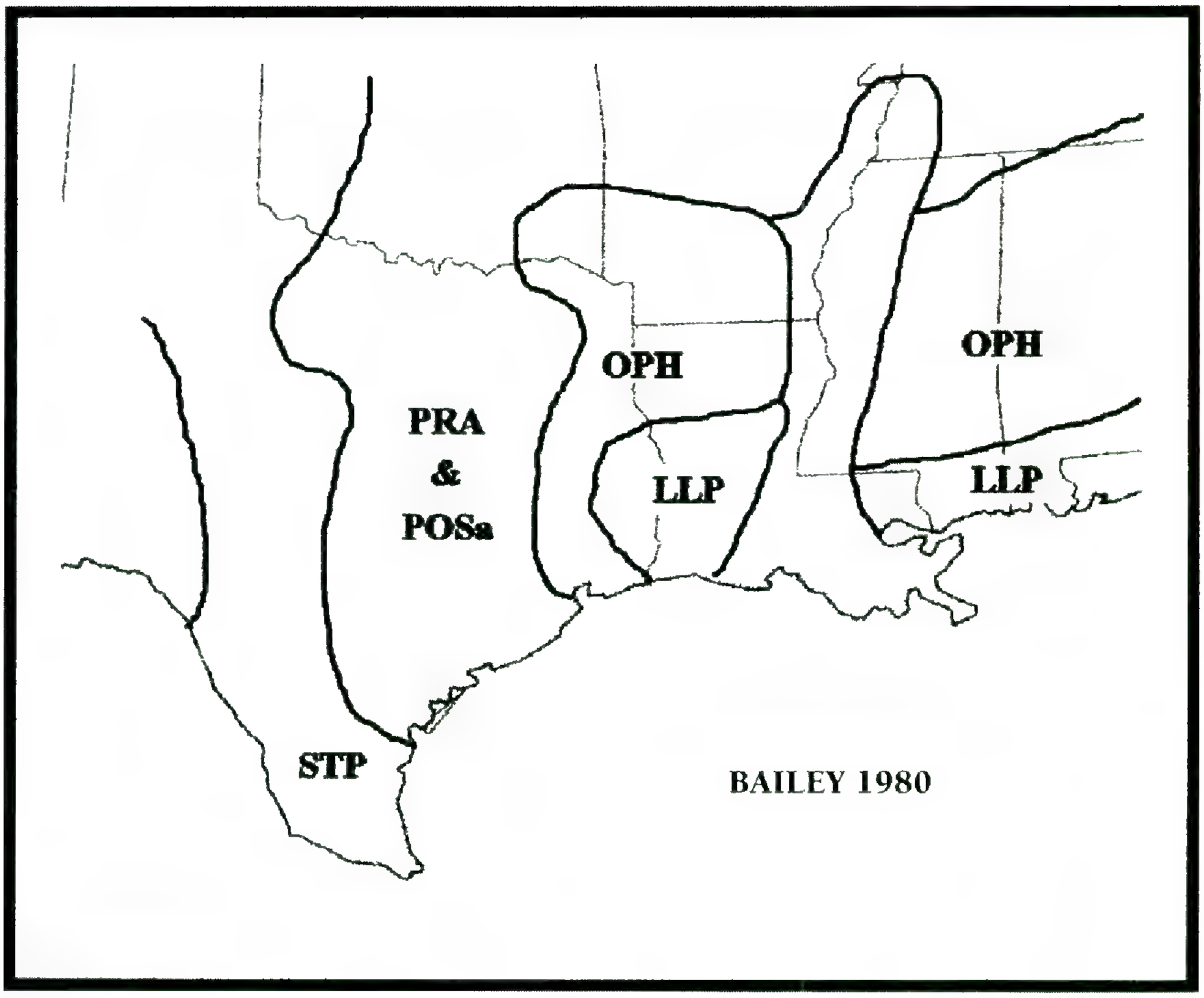


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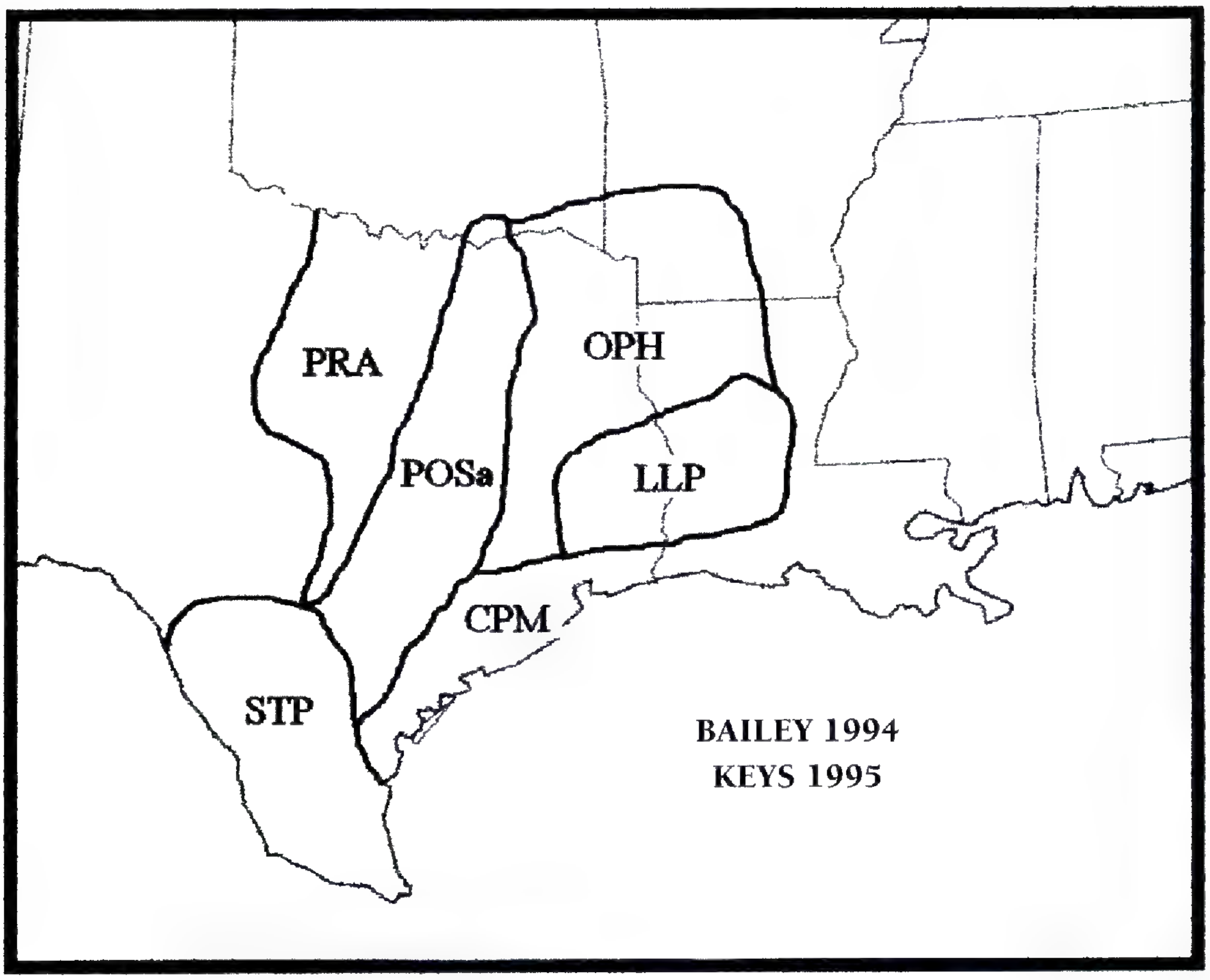


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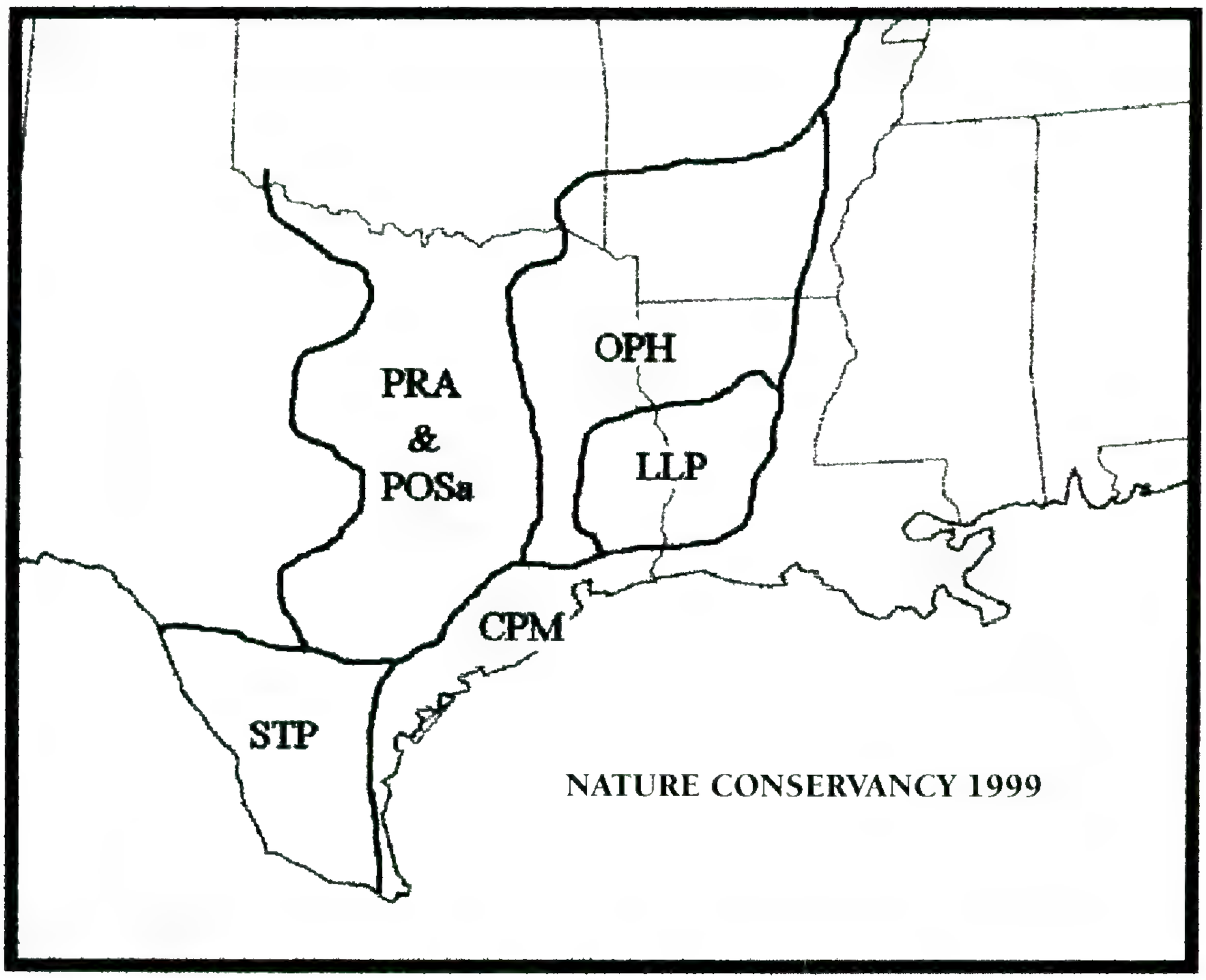


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THE JOHN D. FREEMAN HERBARIUM (AUA): A HISTORY AND CATALOGUE OF VASCULAR PLANT TYPE SPECIMENS

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ABSTRACT

The John D. Freeman Herbarium at Auburn University can trace its roots almost back to the foundation of the institution itself in 1856. By 1867 the campus boasted a natural history museum that housed botanical collections. This was most likely the first organized herbarium at Auburn University. Such notable former faculty as F.S. Earle, L.M. Underwood and especially P.H. Mell, Jr., surmounted early challenges, including a destructive fire in 1887, to establish and maintain a herbarium collection. By 1901, the herbarium housed over 40,000 specimens, including important collections from A.H. Curtiss, G.W. Carver, A.B. Langlois, and J. Darby. Tragically, the herbarium was again destroyed by fire in 1920. Despite this, AUA again emerged from the ashes to reestablish itself as an important state and regional herbarium. Growth at AUA from 1968–1995 was due to the efforts of the late John D. Freeman, who took the herbarium from obscurity to national recognition and quintupled the number of holdings during his tenure. The Freeman Herbarium now contains over 60,000 sheets and is one of the largest and most modern collections in Alabama. The herbarium currently houses 26 documented vascular plant type specimens that are catalogued.

RESUMEN

El Herbario John D. Freeman de la Universidad de Auburn puede rastrear sus raíces desde la fundación de la universidad en 1856. En 1867 la ciudad universitaria disfrutaba ya de un museo de historia natural que albergaba colecciones botánicas. Es probable que éste no fuese el primer herbario organizado que tuvo la Universidad de Auburn. Los primeros profesores destacables como F.S. Earle, L.M. Underwood, y especialmente, P.H. Mell, Jr., vencieron desafíos tempranos, incluso un incendio destructivo en 1887, que perjudicó el mantenimiento de la colección del herbario. En 1901, el herbario albergaba más de 40,000 especies, incluyendo colecciones importantes de A.H. Curtiss, G.W. Carver, A.B. Langlois, y J. Darby. Trágicamente, el herbario fue destruido una vez más por un incendio en 1920. A pesar de la segunda tragedia, el herbario volvió a surgir de las cenizas para restablecerse como uno de los herbarios más importantes del estado y de la región. El crecimiento del herbario desde los años 1968–1995, fue debido a los esfuerzos del ex-curador John D. Freeman, quien tomo el herbario desde sus penumbras hasta ser nacionalmente reconocido y quintuplicó el número de colecciones durante su periodo como curador. Actualmente el herbario John D. Freeman cuenta con más de 60,000 ejemplares y es uno de los herbarios más grandes y modernos del estado de Alabama. Hasta la fecha el herbario alberga 26 ejemplares tipo de plantas vasculares documentadas que están propiamente enumeradas y catalogadas.

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HISTORY

The early history of the John D. Freeman Herbarium can be traced back almost to the foundation of Auburn University itself, and was directly affected by the challenges of establishing an institution of higher education in the late 1850s. Auburn University was originally chartered in 1856 as the East Alabama Male College (EAMC), a Methodist college that officially opened its doors to students in 1859 (Yeager & Stevenson 2000). Botany was the only life science course offered at the college and was first taught by John Darby, A.M., the "Julia Ann Hamiter" Professor of Natural Science (Davis 1992). Darby was a botanist, chemist, and author of one of the earliest floristic works to focus on the southern United States (Darby 1857). This work was intended as a botanical textbook for college and high school students throughout the South and was surely used in Darby's own curriculum, along with other botanical texts by Gray and Chapman. While there is no evidence that an official herbarium collection existed in 1859, Darby no doubt had a set of pressed and dried botanical specimens which he used for teaching botany and plant identification.

Botany continued to be taught until 1861 when EAMC was closed due to the Civil War, in which many of the faculty and students entered the Confederate service (Draughon 1954). The Old Main building, predecessor to current-day Samford Hall, served as a Confederate hospital from 1864–1866 (Yeager & Stevenson 2000). In 1866, the college reopened and Darby was again elected to teach botany (Minutes July 9, 1866). Darby was given emeritus status in 1869 but continued to be listed as a faculty member until 1871. In the 1867 catalogue of the EAMC it lists a "museum which is now being formed" as one of the assets and student recruiting points of the college. This museum housed plants, minerals, fossils, insects, mammals, and Indian relics, among other items. Darby was involved with the college museum and most likely organized the first herbarium collection at Auburn in the late 1860s.

A depressed, post-Civil War economy led to serious financial difficulties that plagued the college during the Reconstruction Period. In 1872, after much debate and considerable objection, the Board of Directors (later Board of Trustees) transferred the EAMC property and buildings to the state of Alabama to establish a land grant college under the provisions of the Morrill Land Grant Act passed by Congress in 1862 (Draughon 1954; Yeager & Stevenson 2000). This act, extended to former Confederate States after the Civil War and ratified by the Alabama Legislature in 1867, provided 30,000 acres of public land for each senator and representative of a state as an endowment to establish a college with the goal "to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life" (Draughon 1954). In 1872, the college was officially named the Agricultural and Mechanical College of

Alabama (A & M College) and the herbarium became an integral part of Agricultural Experiment Station work.

Along with the change from church-college to state-college came changes in administration and some faculty members. In this turbulent time, J.B. Read was selected as the first Professor of Natural Sciences, which included the responsibility of teaching botany. However, his tenure was cut short, when after only eight months the Board of Directors reduced the number of faculty from eight to six, presumably for financial reasons. For the next three years the professorship of Natural Sciences was given to William C. Stubbs, a chemist. However Stubbs, who already taught chemistry, mineralogy and geology, probably did not take on the added responsibility of teaching botany. There are indications that in 1876 botany classes were taught by Professor of Agriculture and President of the young A & M College, Isaac T. Tichenor (botany classes were required by the School of Agriculture course of study according to the early and mid-1870s course catalogues [Yeager & Stevenson 2000]). In 1877, the Board of Trustees hired E.Q. Thornton as Professor of Natural Sciences, but his tenure lasted less than one year due to his unexpected death (Yeager & Stevenson 2000).

Finally, in 1878 the Trustees hired the talented Patrick H. Mell, Jr. to be Professor of Natural Science (Yeager & Stevenson 2000). Under Mell's direction and leadership the college museum holdings were greatly expanded through acquisition of specimens via purchases, exchanges with other institutions, and donations from private collectors and citizens. During Mell's tenure we find the first documentation of the actual size of the herbarium. Reporting for the 1881–1882 school year, Mell stated that the museum had increased in botanical collections from 266 to 1577 (Mell 1882). The following year he reported an increase of 442 botanical specimens for a grand total of 2019 (Mell 1883).

Tragically, in 1887, the herbarium was destroyed when Old Main caught fire and burned. While the number of collections destroyed isn't known, the herbarium was indeed important and growing under Mell's direction. He described his work and the condition of the herbarium prior to the fire as follows:

> "It was my pleasure to begin the preparation of this Botany of Alabama prior to 1887 but the destruction of the Museum by fire that year lost the Institution a valuable herbarium rich in plants collected from Alabama by Prof. Darby, Prof. Thornton, Prof. Stubbs and myself" (Annual Report 1896).

Despite the destruction of the herbarium, Mell published a list of cultivated grasses in Alabama which included the first attempt to list all the grasses that occurred in state (Mell 1889). Prior to the fire, Mell began compiling and writing the first flora of Alabama, to be issued in sections as they were completed (Mell 1896). He was finally able to publish one section of his flora but, unfortunately, no other sections were ever completed (Mell 1896). Incidentally, Charles

T. Mohr, who was concurrently writing his own Alabama flora, considered Mell an upstart in the business of writing the flora of Alabama, and felt threatened by his efforts (Davenport 1979).

Mell's talents were not limited to teaching botany and directing museum collections. Along with these responsibilities, he also served as the first Director of the Alabama Weather Service from 1884–1893, an agency that he created. He developed a system of flag signals used to relay weather conditions and forecasts around the state, a system that was soon adopted by the National Weather Service (Yeager & Stevenson 2000). Later, Mell declined to have his name submitted to President Grover Cleveland to become Chief of the U.S. Weather Bureau (see Mell Scrapbooks 1891–1906, Auburn Univ. Archives). In 1891, he was also appointed Director of the Alabama Experiment Station where he served until 1902 (Yeager & Stevenson 2000). In 1896, Mell was elected Chairman of the Section of Botany and Horticulture of the American Association of Agricultural Colleges and Experiment Stations (Anonymous 1899). After turning down other prestigious offers, including the presidency of Mercer University, Mell finally resigned from Auburn in 1902 to accept the presidency of Clemson College in South Carolina (Kerr 1985).

In late 1895, Lucien M. Underwood came to Auburn as a biologist and began working immediately on the "fungous flora of Alabama, since comparatively little is known of the extent and character of the rich cryptogamic flora of Alabama" (Annual Report 1896). Underwood departed after only one year but not before collecting a great deal and publishing a treatise on edible fungi (Underwood 1896).

Frank S. Earle succeeded Underwood and served as biologist and horticulturist. Earle finished the final preparations on Underwood's "fungous flora of Alabama" and in 1897 published their list of Alabama fungi with Underwood as lead author (Underwood & Earle 1897). This list enumerated over 1100 species of fungi known to occur in Alabama at the time. Also noted was the fact that the college at Auburn was the only institution in the state that maintained a course in botany. They also described some of the collectors and collections in the herbarium at that time (Underwood & Earle 1897). Earle later provided this list of fungi to Charles T. Mohr who included it in the fungi section of his monumental work on the flora of Alabama (Mohr 1901). Earle also studied and collected vascular plants from the unique habitats on and surrounding the metamorphic or granite outcrop regions of eastern Alabama (Earle 1902).

Earle provided excellent documentation of the growth and composition of the herbarium collections from 1896 to 1900. Indications are that Mell's administrative duties kept him away from the herbarium and that by the turn of the 20th century Earle was essentially managing the herbarium. On January 1, 1901, Earle reported the following numbers and composition of the herbarium (Annual Report 1901):

Flowering Plants, etc.	20,606
Fungi	16,950
Lichens	1,006
Mosses, etc	588
Algae	984
TOTAL	40,134

Considering that the herbarium burned in 1887 that was an impressive accumulation of specimens in 13 years.

Earle left Auburn in 1901 and was replaced by Edwin M. Wilcox, Professor of Botany, and self-described "Vegetable Physiologist and Pathologist" (Annual Report 1901). Wilcox was the department head and taught botany classes from 1902–1908. After he arrived, Wilcox immediately began preparing what amounted to the first plant atlas for the state of Alabama. He began a card index of all the plants, including a county map of the state pinpointing each collection location (Annual Report 1902). It is doubtful the project was ever completed because during his six-year tenure Wilcox only referred to the herbarium twice in his annual reports. Other than beginning the plant indexing project, Wilcox's only other reference to the herbarium was a request to get modern cases to hold and preserve the collections (Annual Report 1904). While Wilcox made some strides in maintaining the herbarium, no further reports documenting the size and growth of the herbarium exist after 1901. Most of Wilcox's time was spent working as a plant pathologist, not herbarium curator.

Francis E. Lloyd replaced Wilcox in 1908 as Professor of Botany. The herbarium was apparently poorly maintained and had fallen into disuse during Wilcox's tenure. In Lloyd's first report to the president he stated that, "Steps have been taken toward...the rehabilitation of the herbarium" which, he continues, "is of paramount importance for Experiment Station work as a source of information in matters pertaining to the flora of this section of the country" (Annual Report 1908). Despite Lloyd's emphasis on the importance and necessity of the herbarium, not much was accomplished during his first year. The next year, Lloyd again stressed the need to put the herbarium "into shape for use" (Annual Report 1909). Furthermore, Wilcox's 1904 request for modern herbarium cases must have gone unfulfilled because in 1909 Lloyd stated that the greatest need for the herbarium "is proper housing in the form of tightly constructed cases, since without these we cannot control the insect pests which are peculiarly bothersome here" (Annual Report 1909).

After 1909, little documentation is found relating to the herbarium. It is well known, however, that by 1910 the Botany Department (and herbarium), along with many other life science departments, had moved to a new building on campus. According to the 1910 bulletin, "A handsome and commodious building has been erected for the departments of (1) agriculture, (2) horticul-

ture, (3) botany, (4) entomology, and (5) animal husbandry" (Davis 1992). Furthermore, this building, named Comer Hall, was "thought to be superior or equal to any building in the south" (Yeager & Stevenson 2000). By 1918, the Botany Department occupied the western half of the third floor of Comer Hall. Incredibly, the herbarium was again completely destroyed by flames when a fire engulfed and gutted Comer Hall in October 1920! The total number of specimens lost in this fire is unknown, but by extrapolating from Earle's 1901 report of 40,134 total specimens, an estimate of greater than 50,000 specimens destroyed would be conservative.

The composition of the herbarium before the Comer Hall fire is fairly well documented, at least through the year 1900. The following is a list of some of the valuable collections known to have existed in the herbarium prior to the fire of 1920. Beyond simple documentation, this list serves only to sharpen the tragedy of the loss. First and foremost, the losses included important historical and scientific collections by G.F. Atkinson, C.F. Baker, G.W. Carver, J. Darby, J.F. Duggar, F.S. Earle, A.B. Langlois, P.H. Mell, Jr., W.C. Stubbs, E.Q. Thornton, L.M. Underwood, and an entire set of collections documenting A.H. Curtiss' work on the flora of Florida. Additionally, a large collection of Alabama grasses, an ample seed collection, and 500 exchange specimens from Liverpool, England were also consumed in the blaze. Finally, the loss of documentation for Mell's work on the Flora of Alabama, as well as many other research projects, was especially disappointing (Davis 1992). Other departments that were partially or completely destroyed included Agronomy, Plant Breeding, Soils, Plant Pathology, Horticulture, Animal Husbandry, Entomology, and the administrative offices (Annual Report 1921). The Comer Hall fire was a monumental loss in the history of the herbarium and Auburn University. However, unlike Comer Hall, which was rebuilt in two years, it took many decades to rebuild the herbarium.

While the herbarium was indeed reestablished, there is little information regarding its growth during the years following the fire. In the 1950s, the heirs of Elizabeth F. Andrews, a botanist and author, donated her personal collection of about 2500 plants to the herbarium which included collections by A.W. Chapman. This donation formed the nucleus for further rebuilding efforts. Donald E. Davis, Professor of Botany, came to Auburn in the late 1940s and served as herbarium curator for a time. Davis' students in plant taxonomy and weed science were required to submit specimens and thereby added many collections to the herbarium from 1947–1968 (Davis 1992). Other taxonomists in the botany department during the 1950s and 1960s included Edward T. Browne, Jr. and Alfred C. Koelling (Don Davis, pers. comm.). Browne came to Auburn in 1956 and was herbarium curator until about 1960. The herbarium grew very little during his short tenure, but herbarium records do indicate there was an exchange agreement with the University of Georgia. Browne himself only added about two dozen of his personal collections to the herbarium. Later, Koelling served

as herbarium curator from 1964–1967. In efforts to increase herbarium holdings, Koelling initiated a number of exchanges with other institutions and also added over 750 of his own collections. Herbarium growth from 1922 to 1968 was modest, but by 1968 the herbarium contained a total of 11,300 sheets (Davis 1992).

Herbarium growth from 1968–1995 was due to the efforts of the late John D. Freeman, who emphasized the importance of fieldwork and collecting, and that the herbarium was an essential and valuable botanical research tool. He initiated exchange programs with many institutions and was active in loaning specimens out to various researchers. Freeman directed several graduate student research studies that helped document the flora and assess plant distributions in critical areas throughout the state. These types of studies led to active collecting efforts and, in turn, added greatly to the herbarium holdings. Undergraduate students who took Freeman's systematic botany courses can testify to the emphasis he placed on collecting. His students were required to turn in large collections of 150–200 plants — pressed, identified and labeled — at the conclusion of the course. That amount of collecting kept exchange programs bolstered and greatly enlarged the herbarium holdings. In 1974, Freeman summarized the growth of the herbarium during his first five years at Auburn as follows (Freeman 1974):

Year	Specimens mounted and shelved
1969	3,357
1970	3,737
1971	3,640
1972	2,100
1973	1,420
Total	14,254
Cumulative through 1968	11,300
Present holdings	25,554

Over his career, Freeman took the herbarium from relative obscurity to national recognition. In 1974, the Advisory Committee for Systematic Resources in Botany (1974) selected the Auburn University Herbarium as a National Resource Collection, a collection considered vital for continued science support and research. This designation was given to only 105 (out of a total of 1127) institutions nationwide. Freeman's personal research interests likewise garnered national attention as he focused on the genus *Trillium*. He collected *Trillium* from all across the United States and Japan, naming seven new species including the federally listed southeastern endemic *Trillium reliquum*.

Prior to his death, Freeman helped negotiate the acquisition of the herbarium collection at St. Bernard College (SB) in Cullman County, Alabama. This

invaluable, historic collection of about 5000 sheets was the personal herbarium of Wolfgang Wolf, a prolific botanist in the early 20th century and lay brother of the Order of Saint Benedict. This collection contains not only Alabama plants but also many collections from around the eastern United States and Europe. This acquisition added greatly to the holdings of the Freeman Herbarium and pushed the number of total collections to over 60,000. Ultimately, Freeman increased the number of mounted specimens five-fold in 27 years. In January 1998, the Board of Trustees, in recognition of his enormous botanical contributions, unanimously passed a resolution officially naming the Auburn University Herbarium in honor of Dr. John D. Freeman.

With no permanent curator in place after 1995, activity at the Freeman Herbarium dropped dramatically. For the next three years Jerome Ward, a visiting assistant professor, supervised herbarium activity on a part-time basis and, with the help of students, began the long process of organizing and incorporating the St. Bernard collection.

From 1998 to 2002, Cynthia M. Morton held the post of plant taxonomist and director of the Freeman Herbarium, and in 1999 the author was hired as curator. Under Morton's direction the Freeman Herbarium was brought back to full activity with the resumption of many exchange agreements and increased loan activity. The collections were refoldered using archival quality genus covers, updated taxonomically, and organized geographically. Many misfiled collections were found and duplicate collections removed, which greatly relieved limited cabinet space. Another major emphasis during this time was to have the label information from each specimen entered into a computer database. With the help of students and support from the State Lands Division of the Alabama Natural Heritage Program, this project was completed in 2002. The database is maintained as new specimens are accessioned and added to the collection and is available via the World Wide Web at http://www.auburn.edu/herbarium. The effort to database the herbarium collection has led to the publication of a checklist of Alabama plants compiled from the combined information of the Freeman Herbarium and University of Alabama Herbarium (UNA) (Morton et al. 2002).

The Freeman Herbarium is now one of the largest collections in Alabama and is a vital resource for various natural science departments at Auburn University including the Agricultural Experiment Station, Biological Sciences, Entomology & Plant Pathology, Forestry, Horticulture, Pharmacy, Veterinary Medicine, and Wildlife. The Freeman Herbarium is used throughout the region by other colleges, universities, private companies, and government agencies, and serves as the state herbarium (Alabama Code §1-2-12). The collection houses valuable historic specimens that date to the late 19th and early 20th centuries, including many by E.F. Andrews, A.W. Chapman, and W. Wolf with the earliest collections dating to the 1840s. More recent contributors who have added im-

portant collections to the Freeman Herbarium include V.E. Crouch, A.R. Diamond, J.D. Freeman, S.C. Gunn, R. Kral, H.D. Moore, D.W. Rutland, A.H. Sessler and J.W. Short. While it is richest in specimens from Alabama and the southern United States, the Freeman Herbarium also contains collections from around the country and from many continents in the world. Growth and diversification of the Freeman Herbarium are continuing through open gift and exchange programs and fieldwork.

TYPE SPECIMENS

Currently, the Freeman Herbarium contains over 60,000 mounted vascular plants, of which 26 are documented as types either through citation in original literature or as annotated by a later researcher. This list includes 2 holotypes, 23 isotypes, 1 isoneotype and is arranged alphabetically by family, then by genus. The majority of type specimens are found in Trilliaceae (8) and Asteraceae (7). The reference citation, location (restricted to country, state and county, or equivalent), date, collector, collector number, AUA accession number, and the holotype location, if known, is documented for each specimen.

CATALOGUE OF TYPE SPECIMENS

ARISTOLOCHIACEAE

Hexastylis shuttleworthii (Britten & Baker) Small var. **harperi** Gaddy, ISOTYPE. Sida 12:54. 1987. USA. Georgia. Madison Co.: 9 May 1986, *Gaddy s.n.* AUA 60732. (HOLOTYPE: CLEMS).

ASTERACEAE

Coreopsis grandiflora Hogg ex Sweet var. **inclinata** J. Allison, ISOTYPE. Castanea 66:162. 2001. USA. ALABAMA. BIBB CO.: 15 Jul 1999, *Allison 12086*. AUA 61466. (HOLOTYPE: US).

Erigeron strigosus Muhl. ex Willd. var. **dolomitica** J. Allison, ISOTYPE. Castanea 66:169. 2001. USA. ALABAMA. BIBB CO.: 10 Jun 2000, *Allison 12396*. AUA 61464. (HOLOTYPE: NY).

Liatris ×freemaniana J. Allison, HOLOTYPE. Castanea 66:179. 2001. USA. ALABAMA. BIBB CO.: 18 Jul 1993, *Allison and Stevens 7804*. AUA 61463.

Liatris ×macdanieliana J. Allison, ISOTYPE. Castanea 66:180. 2001. USA. ALABAMA. BIBB CO.: 20 Aug 1994, *Allison 8559*. AUA 61462. (HOLOTYPE: US).

Liatris oligocephala J. Allison, ISOTYPE. Castanea 66:175. 2001. USA. ALABAMA. BIBB CO.: 18 Jul 1993, *Allison and Stevens 7802*. AUA 61461. (HOLOTYPE: GH).

Silphium glutinosum J. Allison, ISOTYPE. Castanea 66:183. 2001. USA. ALABAMA. BIBB CO.: 19 Aug 2000, *Allison 12503*. AUA 61459. (HOLOTYPE: GH).

Silphium perplexum J. Allison, ISOTYPE. Castanea 66:188. 2001. USA. ALABAMA. DALLAS CO.: 18 Aug 1999, *Allison 12153*. AUA 61458. (HOLOTYPE: GH).

BORAGINACEAE

Onosmodium decipiens J. Allison, ISOTYPE. Castanea 66:180. 2001. USA. ALABAMA. BIBB CO.: 1 Nov 1993, *Allison and Stevens 8139*. AUA 61460. (HOLOTYPE: NY).

CYPERACEAE

Carex cumberlandensis Naczi, Kral, & Bryson, ISOTYPE. Sida 19:994. 2001. USA. ALABAMA. WINSTON CO.: 4 May 1991, *Naczi 2868*. AUA 62540. (HOLOTYPE: DOV).

Fimbristylis argillicola Kral, ISOTYPE. Sida 4:128. 1971. MEXICO. MICHOACAN. 18 Aug 1965, *Kral 25509*. AUA 16998. (HOLOTYPE: MICH).

FABACEAE

Dalea cahaba J. Allison, ISOTYPE. Castanea 66:166. 2001. USA. ALABAMA. BIBB CO.: 1 May 1994, *Allison and Stevens 8236*. AUA 61465. (HOLOTYPE: NY).

LAMIACEAE

Scutellaria montana Chapman, ISOTYPE [det. by Robert Kral 1979]. Bot. Gaz. 3:11. 1878. USA. GEORGIA. FLOYD CO.: no date, *Chapman s.n.* AUA 4168.

PORTULACACEAE

Talinum mengesii W. Wolf, HOLOTYPE [det. by Kenneth J. Wurdack 1988]. Amer. Mid. Naturalist 6:153. 1920. USA. ALABAMA. CULLMAN CO.: 9 Aug 1919, *Wolf s.n.* AUA 60731.

RANUNCULACEAE

Clematis morefieldii Kral, ISOTYPE. Annals Missouri Bot. Gard. 74:665. 1987. USA. ALABAMA. MADISON CO.: 17 Jun 1983, *Kral 70176.* AUA 45730. (HOLOTYPE: MO).

SCROPHULARIACEAE

Castilleja kraliana J. Allison, ISOTYPE. Castanea 66:159. 2001. USA. ALABAMA. BIBB CO.: 15 Apr 1998, *Allison 10466.* AUA 61467. (HOLOTYPE: NY).

TRILLIACEAE

Trillium albidum J.D. Freeman, ISOTYPE. Brittonia 27:48. 1975. USA. OREGON. JOSEPHINE CO.: 9 May 1967, *Freeman 596 with Freeman.* AUA 56829. (HOLOTYPE: GH).

Trillium channellii I. Fukuda, J.D. Freeman & M. Itou, ISOTYPE. Novon 6:164. 1996. JAPAN. HOKKAIDO. KUSHIRO DIST.: 21 May 1994, *Fukuda and Itou s.n.* AUA 57091. (HOLOTYPE: MAK).

Trillium cuneatum Raf., ISONEOTYPE. Brittonia 27:34. 1975. USA. NORTH CAROLINA. BUNCOMBE CO.: 13 Apr 1966, *Kral 26254.* AUA 21765. (NEOTYPE: GH).

Trillium decipiens J.D. Freeman, SOTYPE. Brittonia 27:17. 1975. USA. GEORGIA. EARLY CO.: 28 Mar 1968, *Freeman 615 with Murrell, Ihara & Ihara.* AUA 56759. (HOLOTYPE: GH).

Trillium foetidissimum J.D. Freeman, SOTYPE. Brittonia 27:31. 1975. USA. MISSISSIPPI. ADAMS CO.: 30 Mar 1967, *Freeman 535 with Murrell & Ihara.* AUA 16713. (HOLOTYPE: GH).

Trillium gracile J.D. Freeman, SOTYPE. Sida 3:289. 1969. USA. TEXAS. SABINE CO.: 1 Apr 1966, *Samejima 1039 with Freeman & Channell.* AUA 56878. (HOLOTYPE: GH).

Trillium kurabayashii J.D. Freeman, ISOTYPE. Brittonia 27:56. 1975. USA. CALIFORNIA. DEL NORTE CO.: 8 May 1967, *Freeman 594 with Freeman.* AUA 56822. (HOLOTYPE: GH).

Trillium maculatum Raf. f. **simulans** J.D. Freeman, ISOTYPE. Brittonia 27:29. 1975. USA. SOUTH CAROLINA. DORCHESTER CO.: 10 Apr 1966, *Freeman 451a with Freeman.* AUA 56864. (HOLOTYPE: VDB).

Trillium reliquum J.D. Freeman, ISOTYPE. Brittonia 27:21. 1975. USA. GEORGIA. RICHMOND CO.: 20 Mar 1968, *Freeman 625 with Murrell, Ihara & Ihara.* AUA 56862. (HOLOTYPE: GH).

XYRIDACEAE

Xyris tennesseensis Kral, ISOTYPE. Rhodora 80:444. 1978. USA. TENNESSEE. LEWIS CO.: 26 Aug 1969, *Kral 36370.* AUA 32229. (HOLOTYPE: US).

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ABSTRACT

Additions to the vascular floras of four states are reported herein: Colorado (*Calibrachoa parviflora*, *Chamaesyce prostrata*, *Gleditsia triacanthos*, *Oenothera engelmannii*, *Oenothera laciniata*, *Trianthema portulacastrum*, and *Veronica persica*); Iowa (*Deschampsia danthonioides*); Kansas (*Alternanthera caracasana*, *Carex albicans* var. *australis*, *Carex swanii*, *Carum carvi*, *Catharanthus roseus*, *Cyperus diandrus*, *Dichanthelium dichotomum* subsp. *dichotomum*, *Dichanthelium polyanthes*, ×*Elyhordeum montanense*, *Erigeron canus*, *Geranium dissectum*, *Geranium molle*, *Hibiscus syriacus*, *Phyllanthus urinaria* subsp. *urinaria*, *Pyrus calleryana*, *Sagina apetala*, *Sedum sarmentosum*, *Silphium radula*, and *Tridens flavus* var. *chapmanii*); and Oklahoma (*Epilobium leptophyllum*).

RESUMEN

Se hacen adiciones a la flora vascular de cuatro estados: Colorado (*Calibrachoa parviflora*, *Chamaesyce prostrata*, *Gleditsia triacanthos*, *Oenothera engelmannii*, *Oenothera laciniata*, *Trianthema portulacastrum*, y *Veronica persica*); Iowa (*Deschampsia danthonioides*); Kansas (*Alternanthera caracasana*, *Carex albicans* var. *australis*, *Carex swanii*, *Carum carvi*, *Catharanthus roseus*, *Cyperus diandrus*, *Dichanthelium dichotomum* subsp. *dichotomum*, *Dichanthelium polyanthes*, ×*Elyhordeum montanense*, *Erigeron canus*, *Geranium dissectum*, *Geranium molle*, *Hibiscus syriacus*, *Phyllanthus urinaria* subsp. *urinaria*, *Pyrus calleryana*, *Sagina apetala*, *Sedum sarmentosum*, *Silphium radula*, y *Tridens flavus* var. *chapmanii*); y Oklahoma (*Epilobium leptophyllum*).

Continuing field and herbarium studies in the grassland biome of central North America have produced additional records of vascular plants previously undocumented in parts of the region. Herein we report 28 new state records for vascular plants in Colorado (7), Iowa (1), Kansas (19), and Oklahoma (1). Thirteen of these reports are considered to be native occurrences in the region; fifteen (marked with an asterisk) are considered the results of recent introduc-

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tions. These reports update the distribution data contained in *Atlas of the Flora of the Great Plains* (Great Plains Flora Association 1977) and *Flora of the Great Plains* (Great Plains Flora Association 1991). All voucher specimens are deposited in the R. L. McGregor Herbarium (KANU), University of Kansas, unless otherwise indicated.

***Alternanthera caracasana** Kunth (Amaranthaceae). Native to South and Central America, mat chaff-flower has been reported from throughout the southern U.S. (Kartesz & Meacham 1999). Previous reports record this species from the panhandle of Texas and Oklahoma (Great Plains Flora Association 1991). A single specimen confirms its presence in Kansas.

Voucher specimen: **KANSAS. Douglas Co.:** Lawrence, University of Kansas Campus, T12S, R20E, sec 36, SW 1/4, SE 1/4, near 38°57'29"N, 95°14'54"W, elev 305 m, weedy plantings and sidewalk cracks on campus, 30 Aug 2002, *Morse 8534*.

***Calibrachoa parviflora** (Juss.) D'Arcy (Solanaceae). This prostrate annual occurs throughout the southern U.S. and tropical America and is probably a recent introduction into the Great Plains. Freeman et al. (1998) reported it from central Kansas. Two populations were discovered in eastern Colorado in 2000, both along the shorelines of reservoirs.

Voucher specimens: **COLORADO. Bent Co.:** Las Animas, 12 mi N, Adobe Creek Reservoir State Wildlife Area, SE side of Adobe Creek Reservoir, T21S, R52W, sec 4, E1/2, SE1/4, elev 4,140 ft, level, grazed, shortgrass prairie and muddy to sandy shoreline, 26 Jun 2000, *Freeman 15345 & Morse*. **Kiowa Co.:** Eads, 10 mi S, 4.5 mi E, Neenoshe Reservoir, S side, T20S, R47W, sec 9, SW 1/4, SW 1/4 & sec 16, N 1/4, elev 3,930 ft, open, sandy to muddy shoreline and adjacent, wooded perimeter of reservoir, 20 Aug 2000, *Freeman 15982 & Morse*.

Carex albicans Willd. ex Spreng. var. **australis** (L.H. Bailey) Rettig (Cyperaceae). Rettig (1990) recognized three varieties of *C. albicans*. Variety *albicans* occurs in the Great Plains from eastern Nebraska south through eastern Kansas and into central Oklahoma (Rolfsmeier & Wilson 1997; Taylor & Taylor 1994; Yatskievych 1999). Recently, a population of approximately 100 individuals clearly referable to var. *australis* was discovered in southeast Kansas in a sandy, oak woodland. The nearest documented populations in Arkansas (Hyatt 1998) and Missouri (Yatskievych 1999) are more than 250 km away.

Voucher specimens: **KANSAS. Neosho Co.:** Thayer, 0.5 mi W, Thayer City Lake, N side, 37°29'01"N, 95°29'13"W, post oak-blackjack oak woodland on sandstone, gentle S facing slope with a few mesic ravines, 17 Apr 2001, *Freeman 16776*.; Thayer, 0.5 mi W, N side Thayer City Lake, T29S, R18E, sec 31, NW 1/4, NW 1/4, elev 305 m, mowed parkland, picnic area, and open blackjack oak-post oak forest, soil sandy, 23 Apr 2001, *Morse 5486 & W. Michener*.

Carex swanii (Fernald) Mack. (Cyperaceae). *Carex swanii* is broadly distributed throughout the eastern U.S. and southeastern Canada. A small population recently discovered in eastern Kansas extends the range of this species by more than 300 km from the nearest known stations in central Arkansas (Hyatt 1998) and southeastern Missouri (Yatskievych 1999).

Voucher specimen: **KANSAS. Douglas Co.:** Junction of US Hwy 56 and Co Rd 1055 in Baldwin City, 3 mi N, 2.25 mi E, T14S, R20E, sec 13, S 1/2, SW 1/4, near 38°49'30"N, 95°08'30"W, elev ca 290 m, open, black-post-blackjack oak forest and upland tallgrass prairie on N- and W-facing slopes, surfacing sandstone, sandy soil, 27 Jun 2002, *Morse* 8383. [Additional voucher at MICH]

***Carum carvi** L. (Apiaceae). Caraway is a Eurasian biennial that has become established sporadically in waste places in the northern Great Plains (Great Plains Flora Association 1991). The species now is added to the Kansas flora based on a population recently discovered in the extreme eastern part of the state.

Voucher specimen: **KANSAS. Miami Co.:** Somerset, 1 mi E, T17S, R24E, sec 3, SW 1/4, NW 1/4, near 38°36'00"N, 94°45'00"W, elev 275 m, weedy floodplain forest and rocky gravel bars along S side South Wea Creek, 5 Oct 2000, *Morse 5186.*

***Catharanthus roseus** (L.) G. Don (Apocynaceae). A native of the Old World tropics, rosy periwinkle has been planted extensively as an ornamental in the U.S. Kartesz and Meacham (1999) mapped records from scattered states in the southern U.S. Recent observations and a single collection confirm the presence of *C. roseus* as an adventive species in Kansas.

Voucher specimen: **KANSAS. Douglas Co.:** Lawrence, University of Kansas Campus, T12S, R20E, sec 36, SW 1/4, SE 1/4, near 38°57'29"N, 95°14'54"W, elev 305 m, weedy plantings and sidewalk cracks on campus, 30 Aug 2002, *Morse* 8533.

Chamaesyce prostrata (Aiton) Small (Euphorbiaceae). Prostrate mat-spurge is a common annual in the southern half of the Great Plains. Kansas and Nebraska records occur westward to the Colorado border (Great Plains Flora Association 1977), but there are no records for that state. It now may be included based on a single collection from extreme east-central Colorado.

Voucher specimen: **COLORADO. Kit Carson Co.:** Burlington, 3 mi E along US 24, T8S, R43W, sec 35, NW 1/4, NW 1/4, elev 4,010 ft, disturbed, open roadside just S of I-70 overpass, soil silty, 18 Aug 2000, *Freeman 15764 & Morse.*

Cyperus diandrus Torr. (Cyperaceae). *Cyperus diandrus* is confined to the extreme eastern Great Plains (Great Plains Flora Association 1977) except in Nebraska, where it is fairly widespread (Rolfsmeier 1995). In far western Missouri, Yatskievych (1999) mapped records from Jackson and Dade counties. Previous reports of the species in Kansas (Gates 1940) were based on misidentified specimens of the superficially similar *C. bipartitus* Torr. The species now may be included in the Kansas flora based on an overlooked specimen collected 40 years ago. Several recent attempts to relocate this population have been unsuccessful.

Voucher specimen: **KANSAS. Atchison Co.:** Mouth of Independence Creek, 28 Jul 1961, *Blocker 789* [KSC].

***Deschampsia danthonioides** (Trin.) Munro ex Benth. (Poaceae). This tiny annual, native to western North America and South America (Cronquist et al. 1977),

has been reported as adventive in Ohio, New York, and Maine (Kartesz & Meacham 1999). The first record from Iowa, where it apparently was a contaminant in grass seed, is reported here. The site has been revisited several times, but there is no evidence that plants have persisted.

Voucher specimen: IOWA. **Bremer Co.:** Waverly, S edge of town, T91N, R14W, sec 10, SE 1/4, SE 1/4, 42°42'03"N, 92°28'34"W, elev 990 ft, small area of reseeded lawn on W side of US 218 at 2416 4th Street SW, exposed, loamy soil, 6 Jul 2001, *Freeman 17518*.

Dichanthelium dichotomum (L.) Gould subsp. **dichotomum** (Poaceae). *Dichanthelium dicotomum* is known from several counties in extreme western Missouri (Yatskievych 1999), but has not been reported from Kansas. Recent examination of specimens at KANU revealed a single specimen misidentified as *D. acuminatum* (Sw.) Gould & Clark var. *fasciculatum* (Torr.) Freckmann, which represents the first verified record for the state.

Voucher specimen: **KANSAS. Franklin Co.:** 1 mi E, 3 mi S Homewood, ridge of N-facing cliffs above small stream on W side of road, plants in sandy soil, dry, 20 Aug 1976, *Brooks 12447*.

Dichanthelium polyanthes (Schult.) Mohlenbr. (Poaceae). Kartesz and Meacham (1999) mapped records of this taxon, as *D. sphaerocarpon* (Ell.) Gould var. *isophyllum* (Scribn.) Angelo, from throughout the eastern U.S., westward to Missouri, Oklahoma, and Texas. For its part, *D. sphaerocarpon* is common in eastern Kansas, but no attempt has been made to distinguish the other members of the complex to which that species belongs. Recent examination of Kansas specimens identified as *D. sphaerocarpon* at KANU revealed a single specimen of *D. polyanthes*, which represents the first verified record for the state.

Voucher specimen: **KANSAS. Cherokee Co.:** 3.5 mi E Crestline, moist open woodland, 22 Jul 1982, *McGregor 33433*.

×**Elyhordeum montanense** (Scribn.) Bowden (Poaceae). This naturally occurring hybrid between *Elymus virginicus* L. and *Hordeum jubatum* L. subsp. *jubatum* has been reported from nearly a dozen states and provinces in the U.S. and Canada (Kartesz & Meacham 1999). A recently redetermined specimen at KANU is the first record for Kansas.

Voucher specimen: **KANSAS. Republic Co.:** T4S, R2W, sec 28, elev 1,380 ft, silty clay loam, 25 Aug 1995, *Elliott 1162*.

Epilobium leptophyllum Raf. (Onagraceae). *Epilobium leptophyllum* is an herbaceous perennial found in fens, marshes, and seeps throughout the northern and central Great Plains (Great Plains Flora Association 1991), occurring southward to Meade County, Kansas (Great Plains Flora Association 1977). A small population discovered in extreme western Oklahoma, on a seepy, open slope near the Ogallala-Doxey contact is 180 km south-southeast of the southernmost Kansas population.

Voucher specimen: OKLAHOMA. **Roger Mills Co.:** Cheyenne, 3.5 mi S, 4 mi W, Thurmond Ranch, T12N, R24W, sec 4, NE 1/4, 35°32'51"N, 99°44'27"W, elev 2,260-2,300 ft, gently rolling sandsage prai-

rie and mixed-grass prairie with abundant oak mottes, small pond at upper reaches of Sergeant Major Creek, Tertiary Ogallala Formation, 3 Oct 2001, *Freeman 18359 & Morse*.

Erigeron canus A. Gray (Asteraceae). Hoary fleabane grows on rocky, shortgrass prairies in the High Plains from South Dakota and Wyoming, south to New Mexico. Examination of specimens at KANU revealed plants misidentified as *E. pumilus* Nutt., including six from extreme northwestern Kansas, which represent the first verified records of the species from the state.

Voucher specimens: **KANSAS. Cheyenne Co.:** St. Francis, 12 mi N, 12 mi W, upland prairie pasture, top of sandrock ledge, thin soil, 9 Jun 1967, *Stephens 11449 & Brooks*; St. Francis, 12 mi N, 12 mi W, high prairie, hilltop, dry, rocky, gravel soil, 4 Jun 1969, *Stephens 31383 & Brooks*; St. Francis, 12 mi N, 12 mi W, top of rocky, prairie hill, 5 Jun 1981, *Stephens 90302*. **Rawlins Co.:** Atwood, 8 mi SW, dry rocky prairie ridge, 27 Jun 1954, *McGregor 9449*; Beardsley, 3.5 mi S, gravelly prairie hillside, 22 May 1975, *Brooks 9662*; McDonald, ca 11 mi S, 6 mi E, T5S, R35W, sec 7, E $^1/_2$ & sec 8, W $^1/_2$, elev 3,200–3,300 ft, N-S trending canyon that joins Beaver Creek to the N, grazed, upland, shortgrass prairie, extensive outcrops of Ogallala Formation in the area, 30 May 1991, *Freeman & Brooks 3516*.

***Geranium dissectum** L. (Geraniaceae). *Geranium dissectum* is a native of Europe now established throughout the eastern and western U.S. and Canada (Gleason & Cronquist 1991; Kartesz & Meacham 1999). A single record confirms its presence in Kansas.

Voucher specimen: **KANSAS. Labette Co.:** Parsons, E side, open grassy area by Labette Creek along US 160, 7 May 1998, *Holland 9312*.

***Geranium molle** L. (Geraniaceae). Dove-foot crane's-bill is a native of Europe and western Asia (Gleason and Cronquist 1991). It is now a widespread weed in the eastern and western U.S. (Kartesz & Meacham 1999), but records from the Great Plains are rare. A specimen recently was found at KANU among 80 specimens of *G. pusillum* L. and is the only record for Kansas.

Voucher specimen: **KANSAS. Wilson Co.:** Fredonia, 6 mi N, 4 mi W, T28S, R14E, sec 7, SE $^1/_4$, SE $^1/_4$, near old farm house in scrub oak woods, 12 Jun 1995, *McGregor 41124*.

***Gleditsia triacanthos** L. (Fabaceae). Common honey-locust is native to the eastern U.S., apparently occurring naturally westward to central Nebraska and Kansas (Great Plains Flora Association 1977, 1991). However, its native range in the Great Plains has been obscured by its long history of cultivation as a shade tree and in windbreaks and fencerows. The species was not included in the Colorado flora by Weber and Wittmann (1992), but KANU now has two specimens of this tree from the eastern part of the state. Both records are presumably the result of introductions in recent decades.

Voucher specimens: **COLORADO. Kit Carson Co.:** Flagler, 3.5 mi E, Flagler State Wildlife Area, elev 4,710–4,770 ft, rocky, shortgrass prairie on the W side of Flagler Lake, 14 May 2000, *Freeman 14319*. **Yuma Co.:** Beecher Island, 3.5 mi S, dry prairie hillside pasture, 18 Jun 1966, *Stephens 4871*.

***Hibiscus syriacus** L. (Malvaceae). A native of east Asia, Rose-of-Sharon is widely planted in the U.S., occasionally escaping from cultivation (Gleason & Cronquist 1991). Kartesz and Meacham (1999) mapped records from throughout the east-

ern U.S. and in Utah. Steyermark (1977) reported the species as rarely escaping in Missouri. In the Great Plains, *H. syriacus* often persists after cultivation, but escaped plants have not been recorded in our region. A plant discovered in eastern Kansas appears not to have been planted.

Voucher specimen: **KANSAS. Douglas Co.:** Lawrence, T13S, R19E, sec 12, NW 1/4, NW 1/4, NE 1/4, 38°56'39"N, 95°15'01"W, elev 255 m, weedy forest edge along Naismith Creek, 7 Sep 2001, *Morse* 7322.

Oenothera engelmannii (Small) Munz (Onagraceae). Harrington (1954) included Engelmann's evening-primrose in his flora of Colorado; however, Weber and Wittmann (1992) excluded it because the voucher for the report was misidentified. A specimen at KANU confirms that the species occurs in Colorado.

Voucher specimen: **COLORADO. Baca Co.:** Ca 8 mi W of Elkhart, KS, on the W side of Morton County Rd B along the KS-CO border, S of the Cimarron River, T35S, R41W, sec 10, NE 1/4, SE 1/4, elev 3,610-3,620 ft, grazed, upland, rolling, sandsage prairie, soil sandy, 2 Jun 1989, *Freeman 3023*.

Oenothera laciniata Hill (Onagraceae). Weber and Wittmann (1992) stated that cut-leaf evening-primrose must occur in eastern Colorado based on nearby collections from Kansas, Nebraska, and Oklahoma. This species may be added to the Colorado list based on a collection from the extreme southeast part of that state.

Voucher specimen: **COLORADO. Baca Co.:** Ca 8 mi W of Elkhart, KS, on the W side of Morton County Rd B along the KS-CO border, S of the Cimarron River, T35S, R41W, sec 10, NE 1/4, SE 1/4, elev 3,610-3,620 ft, grazed, upland, rolling, sandsage prairie, soil sandy, 2 Jun 1989, *Freeman 3024*.

***Phyllanthus urinaria** L. subsp. **urinaria** (Euphorbiaceae). A native of tropical east Asia, peewater leaf-flower was first documented in North America in 1944 (Webster 1970). The species is now established in the southeastern U.S. and Illinois (Kartesz & Meacham 1999), where it is probably more common than herbarium records suggest (Sundell 1986). Two recent collections confirm the presence of this species in southeast Kansas.

Voucher specimens: **KANSAS. Neosho Co.:** Chanute, S edge in Holiday Park, 29 Sep 1997, *Holland 9286*; St. Paul, near new Farmers National Bank, 2 Oct 1997, *Holland 9289*.

***Pyrus calleryana** Decne. (Rosaceae). A native of China, Bradford pear is widely cultivated as an ornamental tree in the U.S. Kartesz and Meacham (1999) mapped records from more than a dozen states in the central, southeast, and south-central U.S. Cultivated plants often persist after abandonment in the Great Plains, and field observations suggest that the species has escaped in Kansas more frequently than herbarium records indicate. A collection from the eastern part of the state comes from a tree that appears not to have been under prior cultivation.

Voucher specimen: **KANSAS. Douglas Co.:** Lawrence, SE edge. Baker Wetlands, just W pull-in on N side of site, T13S, R20E, sec 18, NE 1/4, NW 1/4, 38°55'40"N, 95°14'00"W, elev 250 m, weedy woodland along edge of wetland, 16 Nov 2000, *Morse 5289, Freeman & Loring*.

***Sagina apetala** Ard. (Caryophyllaceae). Crow (1978) mapped this diminutive, introduced annual from along the west coast of the U.S. and at several widely scattered sites in the southeast. Examination of KANU specimens recently revealed two overlooked specimens of hairy-leaf pearlwort from Kansas.

Voucher specimens: **KANSAS. Leavenworth Co.:** US 24 highway at Basehor, sandy, gravelly soil around roadside pull-off, exposed, 4 May 1983, *Brooks 16545*; US 24 at Basehor, roadside pull-off area, gravelly disturbed site, 8 Jun 1983, *Brooks 16638*.

***Sedum sarmentosum** Bunge (Crassulaceae). Stringy stonecrop is a succulent ornamental native to China (Gleason & Cronquist 1991). Escaped plants have been documented in most states east of the Great Plains (Kartesz & Meacham 1999). A small population recently discovered in eastern Kansas is the first record for the state.

Voucher specimen: **KANSAS. Miami Co.:** Beagle, 2.5 mi N, 2 mi E, T18, R22E, sec 25, S 1/2, NE 1/4, 38°27'22"N, 94°15'15"W, elev 275 m, grazed woodland along trail to S end of tallgrass prairie site, 28 May 2001, *Morse 5856 & Michener*.

Silphium radula Nutt. (Asteraceae). A member of the taxonomically difficult *Silphium integrifolium* Michx. complex, rough-stem rosinweed is reported from scattered populations throughout the southeastern U.S. (Kartesz & Meacham 1999). Previously reported in the Great Plains from Oklahoma and Texas (Great Plains Flora Association 1991), this species has been confirmed in southeast Kansas based on a single collection.

Voucher specimen: **KANSAS. Neosho Co.:** Erie, 0.25 mi S, 5 mi E, along old MKT RR right of way, 17 Jul 2000, *Holland 9959*.

***Trianthema portulacastrum** L. (Aizoaceae). Desert horse-purslane is an introduced species known from widely scattered collections in the southern Great Plains (Great Plains Flora Association 1977, 1991). Three collections were made in 2000 in Kiowa County, Colorado, representing the first records for that state.

Voucher specimens: **COLORADO. Kiowa Co.:** Eads, 8.5 mi S, 4 mi E, Neenoshe Reservoir, NW side, T20S, R47W, sec 6, NE 1/4, elev 3,930 ft, shortgrass prairie immediately W of the reservoir and open to wooded shoreline, 16 May 2000, *Freeman 14545*; Eads, 10 mi S, 4.5 mi E, Neenoshe Reservoir, S side, T20S, R47W, sec 9, SW 1/4, SW 1/4 & sec 16, N 1/2, elev 3,930 ft, open, sandy to muddy shoreline and adjacent, wooded perimeter of reservoir, 20 Aug 2000, *Freeman 15983 & Morse*; Eads, 8.5 mi S, 4 mi E, Neenoshe Reservoir, NW side, T20S, R47W, sec 6, NE 1/4, elev 3,930 ft, shortgrass prairie immediately W of the reservoir and open to wooded shoreline, 20 Aug 2000, *Freeman 16037 & Morse*.

Tridens flavus (L.) Hitchc. var. **chapmanii** (Small) Shinners. (Poaceae). *Tridens flavus* is broadly distributed throughout the eastern U.S., westward through Wisconsin and southward to New Mexico. Variety *flavus* occurs in the Great Plains from southeastern Nebraska, southward through eastern Kansas and into Oklahoma (Great Plains Flora Association 1977). Variety *chapmanii* has been reported from Oklahoma (Kartesz & Meachem 1999). Recent examination of specimens from southern Kansas revealed that this variety also occurs in the state.

Voucher specimens: **KANSAS. Chautauqua Co.:** Sedan, 1.5 mi NE, open blackjack oak woods, hillside, dry rocky sandstone soil, 18 Oct 1969, *Stephens 37321*; Chautauqua, 1 mi S, 1.5 mi E, low woods along small stream, soil sandy, moist, 14 Oct 1976, *Brooks 12832*. **Cowley Co.:** Winfield, 7 mi W, sandy prairie, 3 Sep 1966, *Koch 2100*.

***Veronica persica** Poir. (Scrophulariaceae). Though bird-eye speedwell was overlooked in the Flora of the Great Plains (Great Plains Flora Association 1991), Freeman et al. (1998) reported this introduced annual from Iowa, Kansas, Nebraska, South Dakota, and Wyoming in the Great Plains. According to Weber and Wittmann (1992), previous reports of *V. persica* in Colorado were based on misidentified specimens of *V. polita* Fr. However, a recent collection in eastern Colorado confirms the presence of this species in the state.

Voucher specimen: **COLORADO. Cheyenne Co.:** Cheyenne Wells, S side of town, T14S, R44W, sec 20, NW¼, SE¼, elev 4,260 ft, rest area along US 40 and adjacent Cheyenne County Fairgrounds, well-watered grass in outfield of ball diamond, 2 Oct 2000, *Freeman 16705*.

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ERNEST W. TOLLNER. 2002. **Natural Resources Engineering.** (ISBN 0-8138-1847-8, hbk.). Iowa State Press, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax; www.iowastatepress.com). $99.99, 592 pp., b/w photos, graphs/figs., 7" × 10".

From the back cover: "Natural Resource Engineering examines the physics and engineering aspects of soil and water-quality preservation. Topics include a quantitative overview of the hydrologic cycle, upland erosion and water quality, stream channel design, hydraulics of common management structures, ponds and embankments, drainage and irrigation, and stream and lake quality issues."

Contents: **1)** Natural resources engineering opportunities; **2)** Precipitation; **3)** Infiltration; **4)** Evapotranspiration; **5)** Runoff; **6)** Erosion by water, **7)** Water quality and upland nonpoint pollution; **8)** Open channel hydraulics; 9)Vegetated waterways; **10)** Terraces and diversions; **11)** Hydraulics of water management structures, **12)** Impoundments and embankments; **13)** Shallow groundwater management with drains and wells; **14)** Introduction to irrigation design; **15)** Streamflow processes and lake dynamics. **Appendix A** Ethics, biotic relationships, and resource economics; **Appendix B** Solutions for trapezoidal channels with constrained velocity; **Appendix C** Structure installation and soil-imposed forces; **Appendix D** Land forming computations for surface drainage; **Appendix E** Centrifugal pumps and pumping system design; **Appendix F** Plant water potential; **Appendix G** Unit conversions. Index.

KENNETH N. BROOKS, PETER F. FFOLLIOTT, HANS M. GREGERSEN, and LEONARD F. DEBANO. 2003. **Hydrology and the Management of Watersheds, Third Edition.** (ISBN 0-8138-2985-2, hbk.). Iowa State Press, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax; www.iowastatepress.com). $79.99, 704 pp., b/w photos, graphs/figs., 7" × 10".

Hydrology and the Management of Watersheds, Third Edition is basically a textbook on hydrology and watershed management for students of natural resources. A number of improvements to the third edition reflect the needs of students and instructors. The book is divided into six major sections: **1)** Hydrologic processes and land use; **2)** Erosion, sediment yield and channel processes; **3)** Water quality; **4)** Riparian and wetland management; **5)** Special topics including snow hydrology, watershed considerations for water resource development and engineering applications, hydrologic methods, and tools and technologies for watershed analysis and research; **6)** Socioeconomic considerations in watershed management.

THOMAS R. DEGREGORI. 2002. **The Environment, Our Natural Resources, and Modern Technology.** (ISBN 0-8138-0869-3, hbk.). Iowa State Press, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax; www.iowastatepress.com). $79.99, 576 pp., b/w photos, graphs/figs., 6" × 9".

Contents: **1)** Green consumerism; **2)** Racism, elitism, and environmentalism; **3)** Life in the bush; **4)** Paradise in the Pacific?; **5)** The American Indian: The "original ecologist"?; **6)** Demystifying the environment; **7)** Technology and the "primitive"; **8)** The human endeavor as a creative force; **9)** Technology and the promise of modernity. References, Index.

NEW RECORDS OF *CORCHORUS* (TILIACEAE) FOR MEXICO

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ABSTRACT

Two species of *Corchorus* (Tiliaceae) are reported for Mexico: *Corchorus olitorius* L. of Asian origin and *C. trilocularis* L., native of the tropics of Africa and Asia. The first species was introduced into Brazil and the Antilles toward the end of the 19th century and is now recorded for Mexico from the state of Sinaloa. The second species is known from Veracruz and Chiapas, Mexico, and as well as Panama and Ecuador. The exchange and trade of seeds from other continents could be an important way for their introduction and that might explain the presence of these two species in Mexico. At present six species of *Corchorus* are known to occur in Mexico. A dichotomous key for the identification of the Mexican species of the genus is provided, as well as descriptions of the two species, a map of geographic distributions for these species in America, and their vernacular names.

KEY WORDS: *Corchorus olitorius, C. trilocularis*, aloctonous species, Tiliaceae, Mexico.

RESUMEN

Se dan a conocer dos nuevos registros de especies alóctonas del género *Corchorus* (Tiliaceae): *Corchorus olitorius* L. de origen asiático y *C. trilocularis* L., nativa de los trópicos de África y Asia. La primera especie fue introducido a Brasil y a las Antillas desde finales del siglo 19, en nuestro país se reporta por primera vez del estado de Sinaloa; la segunda especie se registra de Veracruz y Chiapas, México, ademas de Ecuador y Panamá, se desconoce la fecha exacta de su arribo al continente americano. Se propone que el intercambio y comercio de semillas provenientes de otros continentes, puede ser una vía importante para su introducción, lo que podría explicar su presencia en México. En la actualidad son seis las especies reconocidas de este género para México. Se proporciona una clave dicotómica para separar de el género *Corchorus* de México, así como la descripción de las dos especies, un mapa de distribución geográfica para estas especies en América y sus nombres comunes.

PALABRAS CLAVE: *Corchorus olitorius, C. trilocularis*, especies alóctonas, Tiliaceae, México.

INTRODUCTION

The genus *Corchorus* (Tiliaceae) was originally described by Linnaeus in 1753, who included four species in the genus: *Corchorus capsularis* L., *C. hirsutus* L., *C. olitorius* L., and *C. siliquosus* L. At the present time the genus is considered pantropical with approximately 40 species, with about 10 species in the New World (Howard 1989). *Corchorus olitorius* and *C. capsularis*, of Asian-African

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origin, have been cultivated since the XIX century in some tropical regions of America for their well known jute fiber.

In Mexico, Standley (1923) registers the presence of three species: *Corchorus hirtus* L., *C. orinocensis* Kunth, and *C. siliquosus* L.; later Standley and Steyermark (1949) recognize *Corchorus aestuans* L. for Mexico and South America; Fryxell (2001) recognize: *C. aestuans*, *C. siliquosos* and *C. hirtus* for the Flora Novo-Galiciana. In the present work *C. olitorius* and *C. trilocularis* L. are added to the previous list, resulting in six species presently reported for Mexico.

The genus *Corchorus* is characterized as follows: annual or perennial herbs, subshrubs, or shrubs, with simple, stellate, or stellate-dendritic hairs or glabrous; leaves alternate, simple, with stipules, persistent or deciduous; blades dentate, serrate or crenate, occasionally with two teeth prolonged into long setae at base; inflorescences lateral or leaf-opposed, bracteate, shortly pedunculate, 1-to several-flowered umbellate or racemose cymes; flowers hermaphroditic; calyx valvate, sepals 4–5, generally free, often apiculate or caudate at apex; petals 4–5, yellow, free, usually shortly unguiculate, with an inconspicuous glandular patch at the base of each petal; androgynophore usually present; stamens 4 to many, free, filaments free or connate; anthers with two theca, introrse, dorsifixed; ovary 2-to10-locular, ovules 2 to many per locule, placentation axile, parietal, or pendulous; style terete, papillate; capsules cylindrical to subglobose, muricate, glabrous, glabrescent, or pubescent, 2- to 10-valved, valves sometimes with transverse septae adaxially; seeds many and small.

METHODS

Specimens of *Corchorus* were studied in the herbaria CHAPA, ENCB, MEXU, UAS, and XAL. Specialized works on the genus were reviewed, with the morphological characteristics of stem, leaves and fruits being compared with the respective descriptions in the works of Martinez (1981), Edmons (1990), and Halford (1995). For the particular case of *C. trilocularis*, the pubescence of the fruit was observed in the compound microscope. The specimens were also compared with the phototypes of the herbarium S-LINN, deposited in the ENCB herbarium. Synonymies and vernacular names were taken from literature sources.

RESULTS

Two species of *Corchorus* are added to the family Tiliaceae in Mexico, *C. olitorius* and *C. trilocularis*. The first one is native of the region of India and Malaysia and is widely cultivated for its fiber, well known as jute. *Corchorus trilocularis* is native to the region of Africa and Asia and is less important from a economic point of view, not being a commercial crop. A dichotomous key for the identification of all Mexican species of *Corchorus* is included below, followed by morphological descriptions, uses, and specimens examined for each of the two newly reported species, as well as a distribution map (Fig. 1).

KEY TO THE SPECIES OF *CORCHORUS* IN MÉXICO

1. Subligneous more than 1 m tall; ovary with 5–6 celled; capsules with 5–6 _____ **Corchorus olitorius**

1. Herbs smaller than 1 m tall; ovary with 2–4 celled; capsules with 2–4 valves.
   2. Capsules 2 valved; ovary 2 celled.
      3. Shrubs; branchlets subglabrous; leaves glabrous below; ovary puberulent; capsules aplanate with the apex obtuse and with 1–4 minute apical beaks ____ **Corchorus siliquosus**
      3. Herbs; branchlets densely tomentose and hirsute; leaves hirsute or pilose below, ovary densely sericeous; capsules teretes without apical beaks.
         4. Capsules hirsute with trichomes conspicuous ca. 1.5 mm long, lightly curved; stipules and leaves hirsute; calyx hirsute; stamen 40; ovary hispid _____ **Corchorus hirtus**
         4. Capsules glabrous or with trichomes inconspicuous ca. 1 mm de largo, right; stipules and leaves essentially glabrous; calyx glabrous; stamens 20–30; ovary appressed pubescent _____ **Corchorus orinocensis**
   2. Capsules 3–4 valved; ovary 3–4 celled.
      5. Leaves mostly ovate, slightly cordate, base rounded and sometimes with a pair of teeth prolonged; stamens 9–14, capsule oblongoid with 6–8 winged and 3 or 4 apical bifid beak divergent and recurved _____ **Corchorus aestuans**
      5. Leaves narrowly ovate or linear, base obtuse or broadly cuneate never with a pair of teeth prolonged, stamens 20–30, capsule torulose without winged and only one apex straight _____ **Corchorus trilocularis**

Corchorus olitorius L. Sp. Pl. 529. 1753. (**Figs 1, 2**). TYPE: cultivated specimen *Herb. Clifford 209, Corchortus no. 1*, (LECTOTYPE: BM). Lectotype designated by Wild, Fl. Zambes. 2:84. 1963.

Corchorus quinquelocularis Moench, Méth. 248. 1794.
Corchorus decemangularis Roxb., Hort. Beng. 42. 1814.
Corchorus lanceolatus G. Don, Gen. Syst. 1:543. 1831.
Corchorus longicarpus G. Don, Gen. Syt. 1:543. 1831.
Corchorus cartharticus Blanco, Fl. Filip. Ed. 1:442. 1837.
Corchorus malchairi De Wild., Etudes Fl. Bangala & Ubangi 345. 1911.
Corchorus olitorius var. *australiensis* Domin, Biblio. Bot. 89:380. 1927

Vernacular names in other countries, taken from the literature.—bunani waweza, eteke nyamusiri, niimbaswa-lusali, otigu-kal, pombo mgunda (Africa); yute (Argentina); gramigrain (Bahamas); yute, gringuele (Cuba); bogi, koshta, jute, chehuncho, changhas, rajaan, tossa jutee (India); feuilles lalo, lalo, petit lalo, tila-lo (Dominican Republic-Haiti).

Subligneous herb to (1–)2–4 m tall; branchlets glabrous, somewhat angular or sulcate when young, stipules 5–16 mm long, glabrous; leaves with petioles terete, thin, (1–)3–4(–60) mm long, glabrous except for simple hairs on a margin; stipules linear, (7–)10(–12) mm long, pilose or glabrous; blades narrowly ovate to ovate, ovate-lanceolate, (1.5–)10(–12) cm long and (1–)2–5 cm wide, upper and lower surfaces usually glabrous, veins sometimes pilose, base rounded and with two basal setaceous teeth to 10(–15) mm long, margin serrate to crenate-serrate, apex acute to acuminate; inflorescences leaf-opposed, solitary

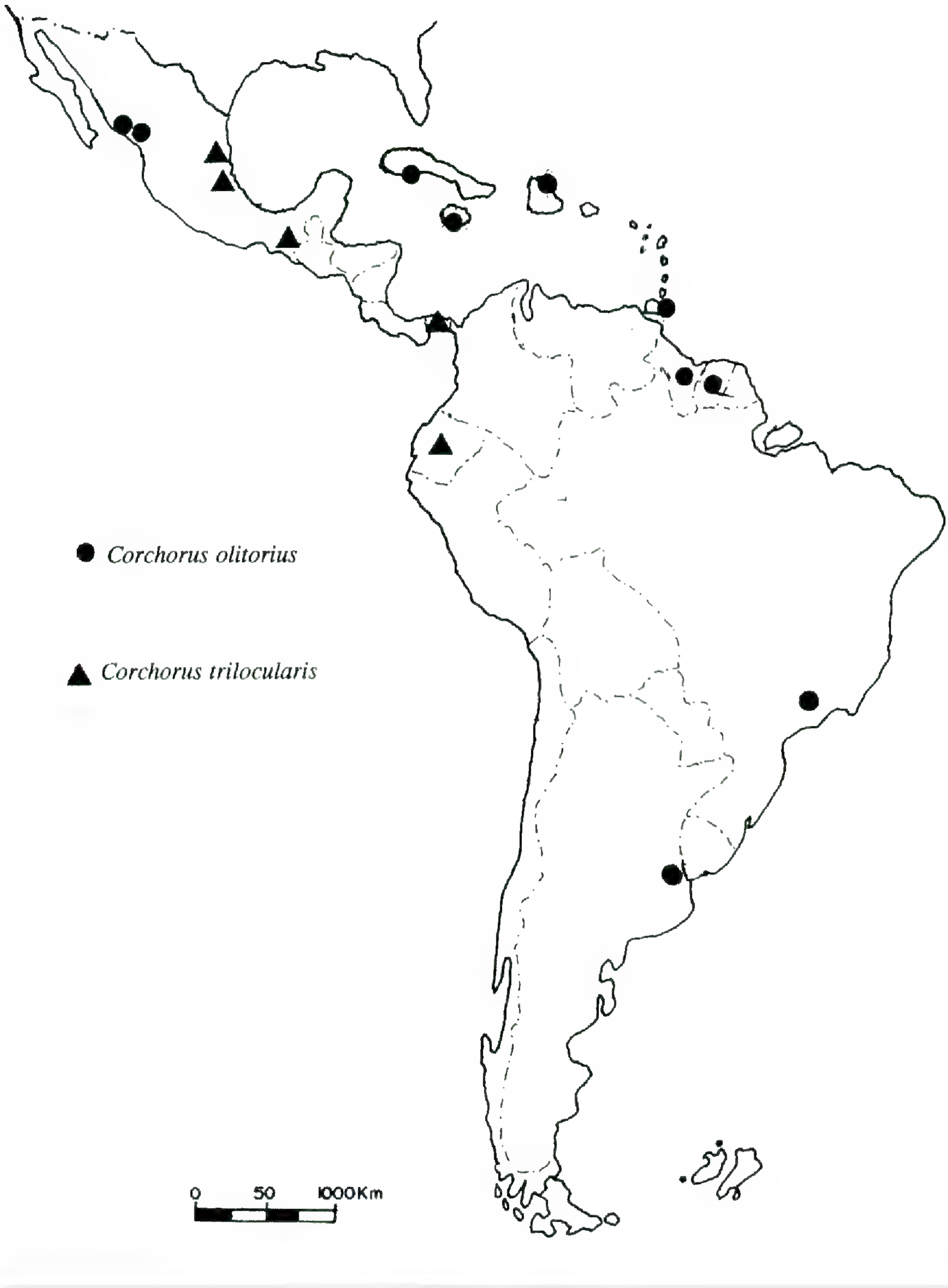


FIG. 1. Geographical distribution in America of *Corchorus olitorius* and *C. trilocularis*

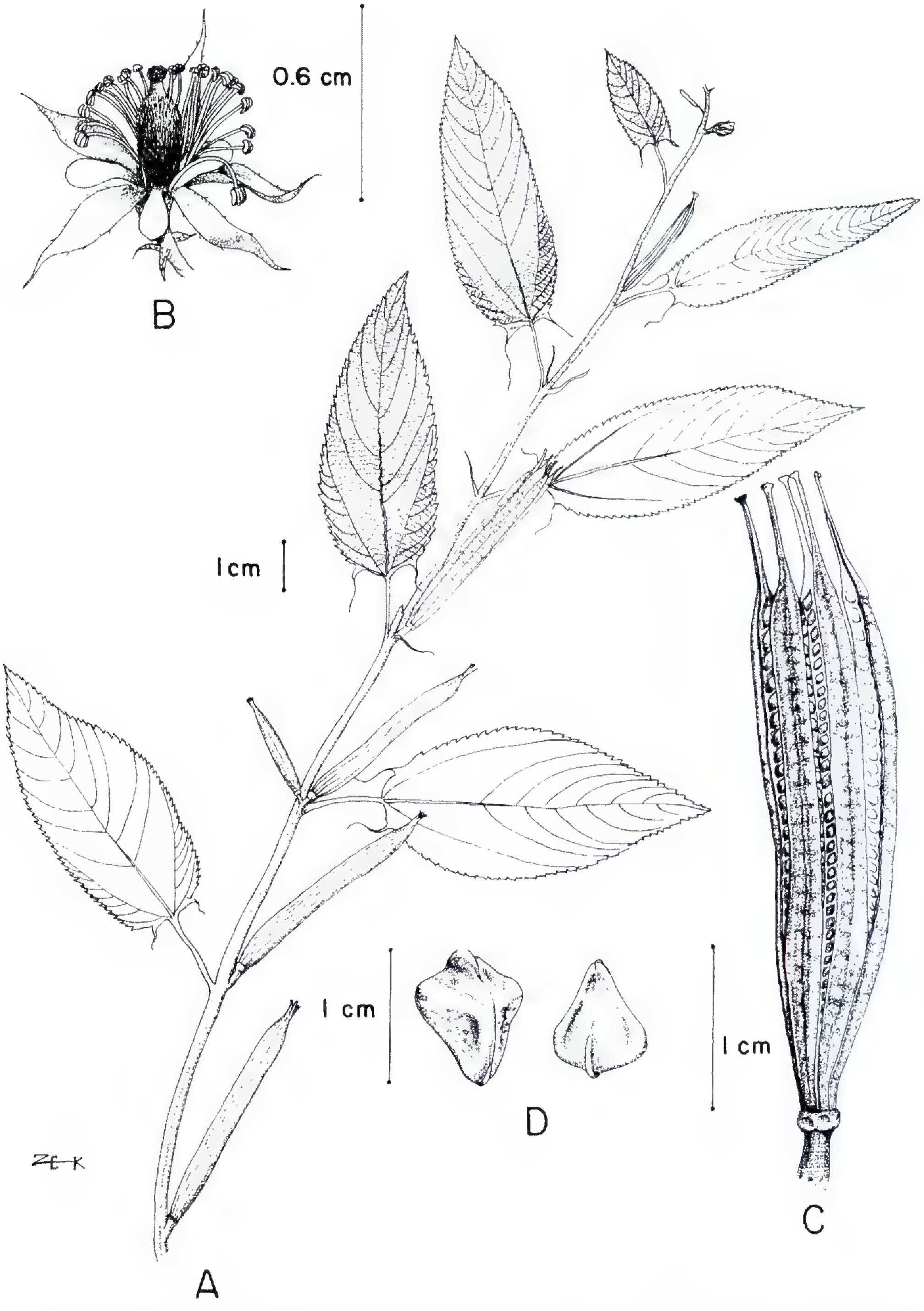


FIG. 2. *Corchorus olitorius* L. **A.** Branch with leaves, buds and fruits; **B.** Immature flower, seen laterally; **C.** Lateral view of the fruit; **D.** Seeds (based on *D. Bates, O. Blanchard and P. Fryxell 1543*).

at the nodes, geminate or ternate, pedicels very short, 1–2 mm long, glabrous, bracts (1–)3–5 mm long, pilose o glabrous; sepals valvate, 7 mm long, linear-lanceolate, concave and glabrous; petals obovate, imbricate, yellow, same length as sepals, 1 mm long and 2–3 mm wide, glabrous but minutely ciliate on margin; androgynophore 2–5 mm long; annulus 5-lobed; stamens 30–50, borne inside of annulus; filaments filiform, 3–4 mm long; anthers dorsifixed, oblong; ovary cylindrical, 5–6 celled, 10-sulcate, minutely setose and glandular, with 36–42 axial ovules per cell; style stout, glabrous, 1–2 mm long, stigma lobed, fimbriate; capsule cylindrical, (3–)4–6(–8) cm long and (3–)4–5(–6) mm wide, appressed to stem, sometimes torulose, dehiscent, 5–6 valvate, transversely septate, apex 3 to 4(–10) mm long; seeds more or less rhomboid, many, black, 1–3 mm (Fig. 2).

Specimens examined: **MÉXICO. Sinaloa:** a 2 Km del ejido La Campana, km 25 carr. Culiacán Guamuchil, municipio de Culiacán, *Leobardo Chávez Montes* y *Fco. Javier Niebla Armenta 124* (UAS); carr. Culiacán-Los Mochis, Km 19, al NE hacia el Cerro La Chiva, *J. A. Prado V.* y *V. Llamas A. 201* (UAS); pie del Cerro El Tule, lado W, orilla de la brecha a la torre de microondas, ca. 5 km de Culiacán, municipio de Culiacán, *Rito Vega. 7295, Hipólito Aguiar H., Cenón Aguirre C.* y *Ricardo Cebreros B.* (UAS); carretera internacional a Costa Rica Km 5, municipio de Culiacán, *Salomé Ochoa Avalos* y *Germán A. Bojórquez B. 162* (MEXU); El Camichin, a 3 km al poniente de Guadalupe de los Reyes, municipio de Cosalá, *Rito Vega 3487, Germán Bojórquez* y *Alejandro Hernández* (CHAPA, UAS); 5 mi S of Mazatlan, *D. Bates, O. Blanchard* y *P. Fryxell 1543* (ENCB).

This species is originally from India and Malaysia, with pantropical distribution where it is appreciated for its fiber (jute).

Corchorus olitorius can be distinguished from the rest of the species in Mexico by being a semishrub 1–2 m, with the stem and leaves glabrous and the inferior border of the leaves with two very long appendices, as well as by the linear capsule, which is thick and glabrous with five valves. It is known from the Pacific Coastal Plain, in the state of Sinaloa, where it grows on the edges of cultivated fields, the banks of roads, in tropical deciduous forest and in thorn forest, on alluvial soils and thin and stony soils, at altitudes that vary between (30–)50 and 700 m. Its presence in America has been reported since the latter part of the XIX century in most of the region of the Caribbean and Brazil (Ricardo et al. 1995; Schumann 1886).

From very early times *Corchorus olitorius* was cultivated as edible in Africa and the Middle East, while as a textile plant it was broadly domesticated in India (Simmonds 1979). Well known as jute, it is presently cultivated in the west of Bengal, Bangladesh, Burma, Nepal, China, Malaysia, and Sri Lanka (Maiti 1995). With the same objective it was introduced into Brazil and Cuba at the end of the 19th century, and in the latter country it has become naturalized in the western part (Schumann 1886; Ricardo et al. 1995; Rodríguez 2000). In Argentina its presence may be more recent (Dimitri & Rial 1952).

This species occurs in Africa in grassland and savannas, and diverse uses are attributed to it there, such as paper production and the extraction of indus-

trial alcohol (Irvine 1961; Edmons 1990). In India, the seeds are used as a purgative and an infusion of the leaves is used as a tonic (Bhandari 1978).

Corchorus trilocularis L. Syst. Nat. ed. 12, 2:369.1767. (**Figs. 1, 3**). TYPE: protologue ARABIA: *Forsskål s.n.* (LINN 691.2) type info. fide Flora of Tropical East Africa (2001).

Corchorus aestuans Forssk, Fl. Aegypt. Arab. 101. 1775. non L.
Corchorus serraefolius DC., Prodr. 1:504. 1824.
Corchorus fruticulosus Vis, Flora 20:443. 1837
Corchorus triflorus Bojer, Hort. Maurit. 43. 1837.
Corchorus asplenifolius E. Mey. non Burch. ex Harv. & Sond., Fl. Cap. 1:229. 1860.
Corchorus somalicus Gandoger, Bull. Soc. Bot. France 69:348 1922
Corchorus rigidiusculus Domin, Biblioth. Bot. 89:381.1926

Vernacular names in other countries, taken from the literature.—apoik, lumere, teke (Africa); hardikaket, kagle-ki-tambaku, karak (India).

Herbs, procumbent to ascending, up 50 cm tall; branchlets moderately covered with pilose pubescence; leaves simple, petioles 3–20 mm long with simple hairs, stipules 2–3(–7) mm long; blades narrowly ovate or linear, (2.5–)4–9(–13) cm long and 0.6–3.0 cm wide, base obtuse or broadly cuneate never with a pair of teeth prolonged, margin dentate or crenate, sometimes with a pair of basal teeth upwardly prolonged 5(–10) mm, apex obtuse or acute, upper surface with scattered simple hairs, lower surface with simple hairs frequently on midvein and secondary veins; inflorescence leaf-opposed, solitary at nodes, geminate or ternate, peduncles and pedicels 1–2(–4) mm long, bracts up 33 mm long, ciliate; sepals 5, linear, (4–)5.5–(–6.3) mm long and 10 mm wide, pilose outside, constricted toward base; petals 5, obovate, (4–)5–(6–)7 mm long and 20–25 mm wide, minutely ciliate on margin; stamens 20–30; ovary cylindrical, 3-locular, 3 mm long, shortly pubescent, stigma fimbriate; capsule torulose without winged and only one apex straight, (2.5–)3.0–5.5(–7) cm long and (1–)2.5–3 mm wide, 3-valvate, pubescence of short simple and fasciculate or palmate hairs, the latter not perceptible without magnification, at maturity more or less glabrous, apex straight, acuminate, valves partially transversely septate adaxially; seeds more or less rhomboid, dark brown to black, 0.8–1 mm diameter.

Specimens examined: **MÉXICO. Chiapas:** Mirador for Chicoasen Dam along road to Tuxtla Gutierrez to the Chicoasen, Municipio San Fernando, *Breedlove 41494* (MEXU). **Veracruz:** Barranca de Pachuquilla, a 2 km al SO de dicha población, municipio de Puente Nacional, *M. E. Medina A.* y *M. Ortiz D. 702* (XAL); Paso de la Milpa, municipio de Actopan, *F. Ventura A. 18001* (ENCB, XAL); Cerro del Brujo, 3 km al N de Jacomulco, municipio de Jalcomulco, *G. Castillo Campos* y *P. Zamora C. 8757* (XAL); Al NW de Jalcomulco, entre Tuzamapan y Jalcomulco, municipio de Jalcomulco, *G. Castillo-Campos, et al. 8347* (XAL); El Hatito, carretera de terracería El Hatito-Caño Prieto, municipio de Paso de Ovejas, *J. E. González H. 184* (XAL); Mata de Caña, municipio de Puente Nacional, *F. Ventura A. 10706* (ENCB). **PANAMÁ. Provincia Los Santos:** Las Trancas-Guararé, *Alcibiades Velázques 24* (MEXU).

Corchorus trilocularis resembles *C. orinocensis* in its herbaceous habit and the size of the leaves. However, *C. trilocularis* is distinguished by the presence of small sepals and petals and the fimbriate stigma; by the ovate-lanceolate leaf

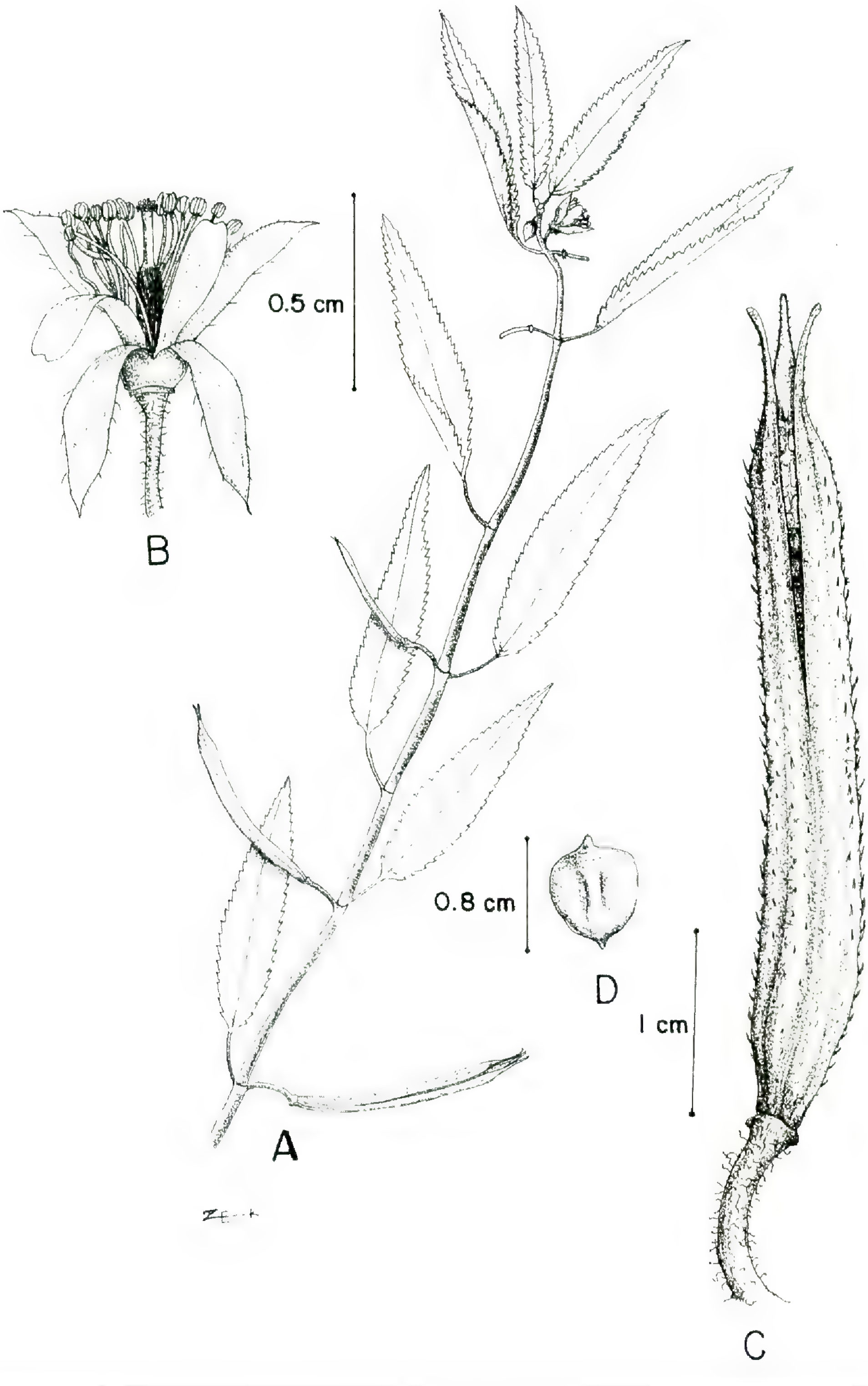


FIG. 3. *Corchorus trilocularis* L. **A.** Branch with leaves, buds and fruits; **B.** Mature flower, seen laterally; **C.** Lateral view of the fruit; **D.** Seeds. (based on *A. Velázquez 24*)

blade (linear-lanceolate in *C. orinocensis*); and, most remarkably, by its three-valved fruits with pubescence of simple and fasciculate or palmate hairs, the latter extremely small and imperceptible at first look (Fig. 3), as opposed to the two-valved fruits with only simple hairs found in *C. orinocensis*.

The presence of *Corchorus trilocularis* in America has not been established previously with certainty, because specimens with two or three-valved fruits have been identified as *Corchorus orinocensis*. In the earlier works of Macbride (1956) for Peru and Robyns (1964) for Panama, the descriptions of *Corchorus orinocensis* correspond to three-valved material.

In the revision of the Neotropical species of the genus *Corchorus*, Tiliaceae, Martínez (1981) assigned Ecuadorian specimens to *Corchorus trilocularis*.

In the revision of the family Tiliacae for the Flora of the Guyanas, Jansen and Meijer (1995) have concluded that only the two-valved specimens should be assigned to *C. orinocensis* based on Kunth's 1823 description.

Corchorus trilocularis is widely distributed in Africa, Asia, and Australia, including in the xerophytic regions of Arabia and India (Bhandari 1978; Edmons 1990). At present there is no clear indication of the date of arrival in the Americas. In Mexico it has been collected in the states of Chiapas and Veracruz, in disturbed areas of deciduous and semi-deciduous tropical forest and in Panama in tropical rain forest.

Although *Corchorus trilocularis* is of little economic importance, it is used at the domestic level; for example, in Africa, the leaves are used in traditional medicine to reduce swellings; an infusion of leaves and branchs is used to produce an alcoholic drink; the seeds are used for certain stomach disorders and to induce vomiting; and it is used as an ornamental plant and as food for livestock (Edmons 1990).

CONCLUSIONS

With these two new reports of *Corchorus*, the number of species known for Mexico rises to six. *Corchorus olitorius* is presently known only from Sinaloa, although its presence in the region of the Caribbean and South America as a useful plant has long been known. Its origin in the Indo-Malay region and its discovery in the Pacific coastal plain in Mexico leads to the supposition that trade of agricultural products, mainly seeds with Oriental countries, has been the route of introduction of the species into Mexico.

In Mexico *Corchorus trilocularis* behaves as weed adapted to the disturbed conditions in southern Mexico, in dry and sub-humid warm vegetation types and in cloud mountain forest. In the Old World it is a characteristic species of the arid zones of Africa, Arabia, and India, in areas of cultivations, grasslands, savannas, and xerophyllous shrubs, while it is also present in the warm-humid zones of India and Australia. Its presence in the Ecuador and part of Central America leaves unanswered questions about this apparently disjunct distribution.

In the specimens of *C. trilocularis* collected in Mexico and Central America, we observe that the pubescence of the mature capsule is of simple and fasciculate trichomes similar to specimens collected in Australia (Halford 1995). Specimens collected in Africa present mature capsules with simple and palmate trichomes (Edmons 1990).

It seems likely that more intensive collection in Mexico, Mesoamerica, and South America will lead to a more definite hypothesis as to the manner and route of introduction of the species into the New World, including whether the introduction is recent or ancient.

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BOOKS FROM IOWA STATE PRESS

ROBERT F. BARNES, C. JERRY NELSON, MICHAEL COLLINS, and KENNETH J. MOORE (Editors). 2003. **Forages: An Introduction to Grassland Agriculture, 6th Edition. Volume 1.** (ISBN 0-813-80421-3, hbk.). Iowa State Press, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax; www.iowastatepress.com). $79.99, 576 pp., b/w photos, graphs/figs., 7" × 10".

Contents: ***Part I:*** *Characteristics of Forage Species* **1)** Forages and Grasslands in a Changing World; **2)** Structure and Morphology of Grasses; **3)** Structure and Morphology of Legumes and Other Forbs; **4)** Physiology of Forage Plants; **5)** Environmental Aspects of Forage Management; **6)** Grasses for Northern Areas; **7)** Grasses for Southern Areas; **8)** Legumes for Northern Areas; **9)** Legumes for Southern Areas; **10)** Forbs; *Compendium;* ***Part II:*** *Forage Management* **11)** Forage Establishment; **12)** Forage Fertilization and Nutrient Management; **13)** Integrated Pest Management in Forages; **14)** Naturalized Grassland Ecosystems and Their Management; **15)** Forage Improvement and Seed Production; ***Part III:*** *Forage Utilization* **16)** Forage Quality; **17)** Forage Utilization; **18)** Forage Related Animal Disorder; **19)** Preservation of Forage as Hay and Silage; **20)** Grazing Management Systems. Appendix; Common and Botanical Names of Forages; Glossary; Index.

RICHARD J. SOFFE (Editor). 2003. **The Agricultural Notebook, 20th Edition.** (ISBN 0-632-05829-3, pbk.). Blackwell Science, Osney Mead, Oxford OX2 0EL, UK (Orders: Iowa State Press, 2121 State Avenue, Ames, IA 50014, U.S.A.; 1-800-862-6657, 1-515-292-3348 fax; www.iowastatepress.com). $64.99, 760 pp., graphs/figs., 7" × 10".

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ADDITION TO FLORA MESOAMERICANA: A NEW RECORD OF *THELYPTERIS* (THELYPTERIDACEAE) FOR CHIAPAS, MEXICO

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ABSTRACT

Thelypteris rhachiflexuosa Riba, described from Veracruz is recorded from Chiapas, where it was found in Northern Highlands. Additional data about distribution, habitat, and morphology are discussed.

RESUMEN

Thelypteris rhachiflexuosa Riba, descrito de Veracruz, es registrado para las Montañas del Norte de Chiapas. Se discute información sobre su distribución, hábitat y morfología.

INTRODUCTION

The genus *Thelypteris* comprises about 900 species—distributed around the world—with high diversity in the tropical and subtropical regions. One hundred thirty three (133) species have been recorded for Mesoamerica and about 50% of these are found in Chiapas (Smith 1995).

The Northern Highlands of Chiapas is one of the less well known areas from a botanical viewpoint (Breedlove 1981). Nevertheless, a few studies have been carried out in this area (Pérez & Sarukhán 1970; López-Mendoza 1980), and it has been considered one of the most important regions for endemic taxa (Schutzman et al. 1988; Went 1989, 1998). Unfortunately it is also one of the most altered places, due mainly to anthropogenic activities (cattle raising and sun coffee plantation). This has resulted in loss of both primary vegetation and floristic diversity.

During a floristic exploration of the tropical forests in the Northern Highlands in 1999, we collected several samples of ferns, among them a *Thelypteris* with a flexuose rachis and 2–4 pairs of alternate, undulate pinnae.

This specimen proved to be *Thelypteris rhachiflexuosa* Riba, previously known only from the region of Los Tuxtlas, Veracruz. This species was collected and described by Riba (1989) and recorded as endemic to Veracruz (Ibarra-Manríquez et al. 1997; Riba & Pérez-García 1997; Riba 1998).

Voucher specimen: **MEXICO. Chiapas:** Mpio. Amatán, Mt. Palmar, 10 km E of Amatán, Northern Highlands, 23 May 1999, 800 m, *Pérez-Farrera 1967*; (Herbarium of Escuela de Biologia, UNICACH; CHIP) (Fig. 1). *Thelypteris rhachiflexuosa* is being grown in the Botanical Garden "Faustino Miranda" in the Instituto de Historia Natural under accession number 085.

In Chiapas this species occurs in "bosque tropical perennifolio" (tropical rain forest) according to Rzedowski (1978), or "selva alta perennifolia" (Miranda & Hernández-X. 1963). This vegetation is comprised of three strata. The first stratum is dominated by *Brosimum alicastrum* Sw., *Dialium guianense* (Aubl.) Sandw., *Manilkara zapota* (L.) Royen, *Guatteria anomala* R.E. Fries, *Calophyllum brasiliense* Camb., *Pouteria sapota* (Jacq.) H.E. Moore & Stearn, and *Pterocarpus hayensii* Hemsl. In the middle stratum are usually *Bursera simaruba* (L.) Sarg., *Pimenta dioica* (L.) Merrill, *Miconia trinervia* (Sw.) D. Don. ex Loud., *Oreopanax xalapensis* (Kunth) Decné & Pl., *Trophis racemosa* (L.) Urban, *Saurauia belizensis* Lundell, and *Dendropanax arboreus* (L.) Planch. & Decne. The third stratum or understory typically consists of *Astrocaryum mexicanum* Liebm., *Chamaedorea concolor* Martius, *Chamaedorea elegans* Martius, *Chamaedorea tepejilote* Liebm., *Chamaedorea arenbergiana* Wendl. *Desmoncus chinantlensis* Liebm. *Begonia nelumbiifolia* Cham. & Schlecht., *Anthurium pedatoradiatum* Schott, *A. schlechtendalii* Kunth. In addition, some epiyphytes and hemiepiyphytes are found in these habitats, e.g., *Monstera deliciosa* Liebm., *Anthurium pentaphyllum* (Aublet) G. Don. var. *bombacifolium* (Schott) Madison, and *Polypodium* sp. *Thelypteris rhachiflexuosa* is sometimes found in secondary vegetation or coffee plantations.

The soils in this area are red clay derived from lutitas (López-Mendoza 1980). The topography is abrupt, with steep slopes (70%). The landscape is karstic and the bedrock consists of a complex of Eocene and Oligocene marine limestone (López-Hernández 1994; Pérez & Sarukhán 1970). This species occurs at elevations from 600–800 m (Fig. 2).

DISCUSSION

Thelypteris rhachiflexuosa is in the subgenus *Goniopteris*. In Mesoamerica about 41 species are known in this subgenus, with about 34 species in Mexico (Yatskievych, pers. comm.), and approximately 17 in Chiapas (Smith 1995). There are still taxonomic problems at the species level.

This record for Chiapas extends the distribution of this species into Mesoamérica. This taxon has a distribution pattern similar to that of other woody species restricted to the Caribbean slope, an area including Los Tuxtlas, Veracruz and northern mountains of Chiapas (Wendt 1998). We expect that *T. rhachiflexuosa* will also be found in the State of Tabasco.

Thelypteris rhachiflexuosa is similar to *T. oroniensis* L.D. Gómez, endemic to Costa Rica, in its zig-zag rachis, but differs from that species in its meniscioid secondary veins. The specimen of *T. rhachiflexuosa* collected in Chiapas dif-



FIG. 1. Herbarium voucher *Thelypteris rhachiflexuosa* from Chiapas.

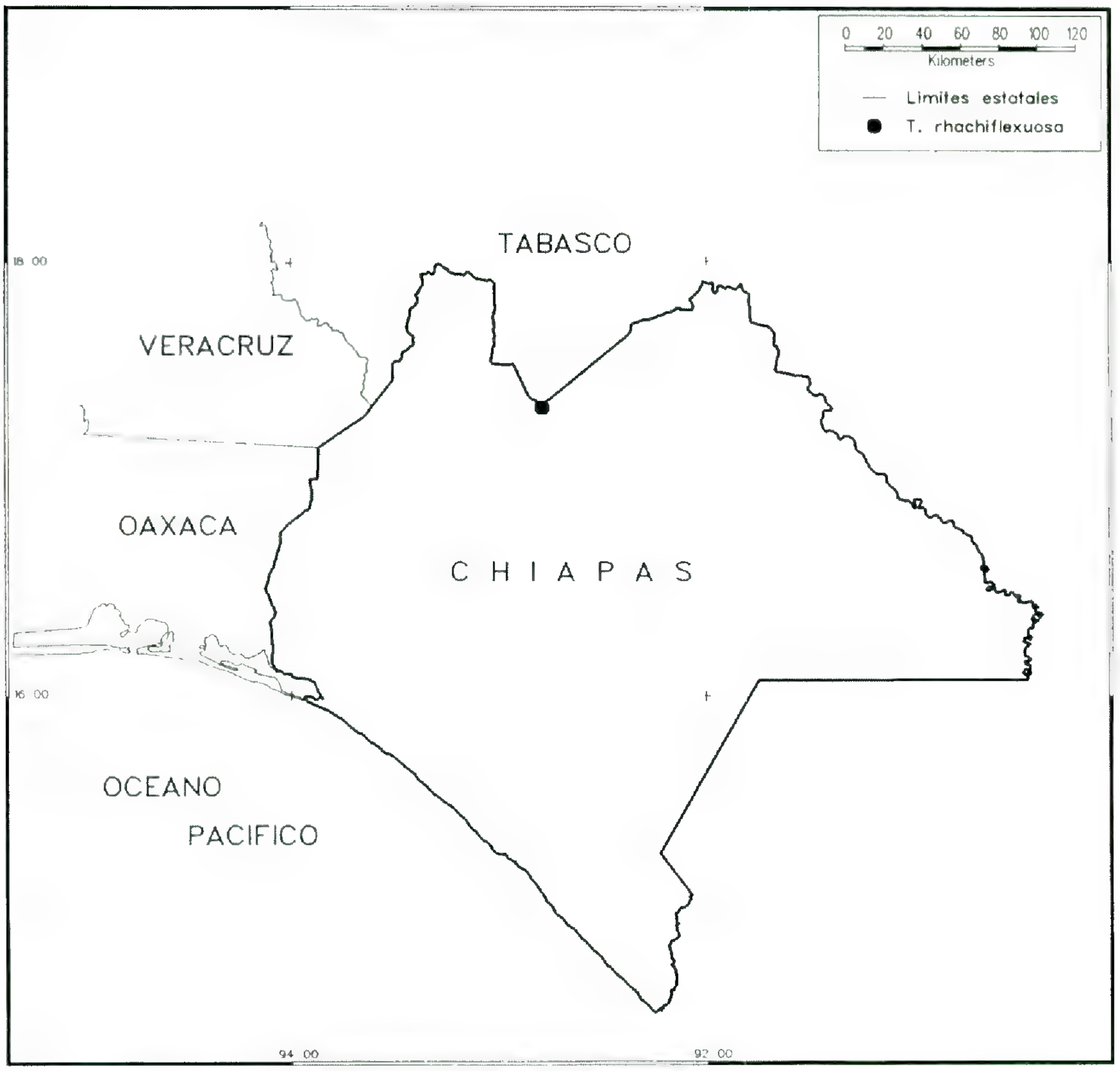


Fig. 2. Distribution of *Thelypteris rhachiflexuosa* in Chiapas.

fers slightly from the voucher collected in Veracruz in having more setulose sori. *Thelypteris rhachiflexuosa* sometimes grows with *Thelypterisghiesbreghtii* (Hook.) C.V. Morton and differs from this species with regard to straight rachis, costae, veins and leaf tissue moderately to densely hairs below.

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Note.—The first and third authors would like dedicate this manuscript to the memory of Dra. Ramón Riba y Nava Esparza, who passed away three hours after checking the identity of this species.

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BOOKS FROM UNIVERSITY OF ARIZONA PRESS

THEODORE H. FLEMING and ALFONSO VALIENTE-BANUET (Editors). 2002. **Columnar Cacti and Their Mutualists: Evolution, Ecology, and Conservation.** (ISBN 0-8165-2204-9, hbk.). The University of Arizona Press, 355 S. Euclid, Ste 103, Tucson, AZ 85719, U.S.A. (Orders: 520-621-1441, fax 520-621-8899; www.uapress.arizona.edu). Price not given, 371 pp., b/w photos, maps, 6" × 9 1/4".

From the preface: This book is the result of a conference held in Tehuacan City, Puebla, Mexico (1998) and focuses on the evolution, ecology (sensu lato), and conservation needs of columnar cacti and their vertebrate mutualists. There are 17 chapters divided into three sections: **1)** Geology and Evolution; **2)** Anatomy and Physiology; **3)** Population and Community Ecology and Conservation.

NATHAN F. SAYRE. 2002. **Ranching, Endangered Species, and Urbanization in the Southwest: Species of Capital.** (ISBN 0-8165-2158-1, hbk.). The University of Arizona Press, 355 S. Euclid, Ste 103, Tucson, AZ 85719, U.S.A. (Orders: 520-621-1441, fax 520-621-8899; www.uapress.arizona.edu). $48.00, 320 pp., 18 b/w photos, 4 maps, 6" × 9".

Contents: **1)** The social production of the endangered masked bobwhite; **2)** The cattle boom in the Altar Valley; **3)** The formation of ranching; **4)** Producing nature; **5)** The urbanization of ranching; **6)** Restoring grass and quail; **7)** Producing a state of nature; **8)** "Where wildlife comes naturally!"; **9)** Counterfeiting conservation. Notes, References, Index.

POLYGONUM DOUGLASII SUBSP. *JOHNSTONII* (POLYGONACEAE) NEW FOR CANADA

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Polygonum douglasii E.L. Greene subsp. *johnstonii* (Munz) Hickman is native to western North America. Its presence in southwestern Canada was to be expected since it has been recorded from several adjacent American states—Washington, Idaho, Montana and North Dakota (Kartesz 1999)—that share common habitats with the southern parts of the western Canadian Provinces. It has not been recorded from Saskatchewan until now (Vernon Harms, pers. com.). Subspecies *johnstonii* grows on sandy soils, open rocky places in dry grass communities and Ponderosa forests. It flowers from June to August. Four point collections in the grasslands from southern Saskatchewan are indicated on the map that accompanies the herbarium label of the specimen cited. Since its occurrence is also probable in Alberta and British Columbia, further research is necessary to determine its exact distribution in Canada. The closest related taxon is *Polygonum douglasii* subsp. *douglasii* (Hickman 1984). *Polygonum douglasii* subsp. *johnstonii* differs from subsp. *douglasii* mainly through the erect, almost sessile or short-pedicellate achenes. Subspecies *douglasii* has spreading or reflexed, long-pedicellate achenes). Other distinguishing characters, an identification key and line drawings of the two taxa can be found in Hickman (1993).

Voucher specimen: **CANADA. Saskatchewan:** Grasslands Park, 9 mi SE of Val Marie, 17 Jul 1989, *E.R. Hooper 11110* (USAS).

ACKNOWLEDGMENTS

We thank Vernon Harms for confirming the novelty of the taxon in Saskatchewan; George Ledingham for the additional information about the collection from USAS; and Luc Brouillet for reviewing the manuscript.

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KOENIGIA ISLANDICA (POLYGONACEAE) NEW FOR UTAH

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Koenigia islandica L. is a circumpolar species that extends south in North and South America, in scattered alpine summits of the Rocky Mountains and the Andes (Löve & Sarkar 1957; Freeman, unpublished). It occurs in alpine communities growing in permanently moist gravel or moss, especially around persistent nival basins near small streams, ponds, and lakes at elevation up to 3800 m (Freeman, unpublished). Sub-national conservation status has been assessed to S1 (critically imperiled) in Montana, Wyoming (U.S.A.), Alberta and Manitoba (Canada), S2 (imperiled) in Colorado (U.S.A.) and S2S3 in British Columbia, Labrador and Newfoundland (Canada). The species is possibly extirpated (SH) from Ontario, Canada (NatureServe Explorer 2002).

Voucher specimen: **U.S.A. UTAH. Duchesne Co.:** Ashley Forest, Uinta Mountains, Uinta drainage, Gilbert Bench E of Gilbert Peak, T5NR4W S24 N1/2 USM, elevation ca. 3600 m, alpine community, growing in a seep, apparently rooted in moss, 9 Aug 2000, *S. Goodrich, A. Huber, F. Bartlett and J. Frandsen 26308 (5)* (BRY, NY).

Koenigia islandica can be mistaken with seedlings of *Epilobium* spp. or with dwarf plants of *Polygonum minimum* Small. In the latter case, it can be easily distinguished by its opposite or whorled leaves and the flowers with 3 tepals and 3 stamens (*P. minimum* has alternate leaves and flowers with 5 tepals and 8 stamens).

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We warmly thank Stanley Welsh for confirming our finding and Craig Freeman for sharing with us his unpublished treatment of *Koenigia* for FNA.

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BOOKS FROM UNIVERSITY OF ARIZONA PRESS

GARY PAUL NABHAN. Forewords by WENDELL BERRY and MIGUEL ALTIERI. 2002. **Enduring Seeds: Native American Agriculture and Wild Plant Conservation.** (ISBN 0-8165-2259-6, pbk.). The University of Arizona Press, 355 S. Euclid, Ste 103, Tucson, AZ 85719, U.S.A. (Orders: 520-621-1441, fax 520-621-8899; www.uapress.arizona.edu). $19.95, 250 pp., 6" × 9".

Contents: **Part 1: A New World Perspective; 1)** The flowering of diversity; **2)** Diversity lost: The wet and the dry tropics; **3)** Fields infused with wildness; **4)** Invisible Erosion: The rise and fall of native farming; **5)** A spirit earthly enough: Locally adapted crops and persistent cultures; **6)** New and old ways of saving: Botanical gardens, seed banks, heritage farms, and biosphere reserves; **Part 2: The Local Parables; 7)** Wild-rice: The endangered, the sacred, and the tamed; **8)** The exile and the holy anomaly: Wild America sunflowers; **9)** Lost gourds and spent soils on the shores of Okeechobee; **10)** Drowning in a shallow gene pool: The factory turkey; **11)** Harvest time: Northern plains agricultural change; **12)** Turning foxholes into compost heaps, shooting ranges into shelterbelts. Biological Essays, Literature Cited, Index.

RAYMOND M. TURNER, ROBERT H. WEBB, JANICE E. BOWERS, and JAMES RODNEY HASTINGS. 2002. **The Changing Mile Revisited: An Ecological Study of Vegetation Change with Time in the Lowser Mile of an Arid and Semiarid Region.** (ISBN 0-8165-2306-1, hbk.). The University of Arizona Press, 355 S. Euclid, Ste 103, Tucson, AZ 85719, U.S.A. (Orders: 520-621-1441, fax 520-621-8899; www.uapress.arizona.edu). $75.00, 334 pp., 9" × 12".

Contents: **1)** The desert habitat; **2)** The influence of American Indians, Spaniards, Mexicans; **3)** The influence of Anglo-Americans; **4)** The oak woodland; **5)** The grassland; **6)** The desert; **7)** The pattern of change; **8)** Change and cause. Appendixes: **1)** Climate stations in Arizona and Sonora; **2)** Common and Latin plant names; **3)** Details of photographic stations and photo credits. Notes, Literature Cited, About the Authors, Index

NOTES ON TWO SPECIES OF *AGALINIS* (SCROPHULARIACEAE) INCLUDING *AGALINIS HARPERI*, NEW TO TEXAS

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ABSTRACT

New distribution records of *Agalinis* species are reported including *Agalinis harperi* Pennell new to Texas.

RESUMEN

Se citan nuevas localidades de especies de *Agalinis* incluyendo *Agalinis harperi* Pennell nueva para Texas.

Agalinis harperi Pennell grows in the southeastern United States from South Carolina westward to Louisiana (Godfrey & Wooten 1981; Vincent 1982). It is on the Louisiana Natural Heritage Program's watch list for rare species (Louisiana Natural Heritage Program 1999). Hays (1998) recently clarified the nomenclature for this species, previously named *A. pinetorum*.

A population of approximately 500 plants was discovered in northern Newton County growing in an open rocky barren on Scrappin Valley, a hunting preserve and Habitat Management Area (HMA) for the Red-cockaded woodpecker owned by Temple-Inland Forest Products Corp. The species has not been reported for Texas (Hatch et. al. 1990; Jones et. al. 1997), but it has been collected in four Louisiana parishes bordering Texas (MacRoberts 1989; Thomas & Allen 1998; Vincent 1982). *Agalinis harperi* is similar to *A. purpurea* (L.) Pennell but can be distinguished by the more narrowly-linear, usually ascending leaves (0.5–1 mm) and by the longer distance between nodes, and thus by a more sparse vegetative appearance.

Voucher specimen: **TEXAS. Newton Co.:** Scrappin' Valley, open, rocky Catahoula barren in RCW cluster 2368E, 31.144499° N and 93.798482° W, 15 Oct 1999, *Keith* s.n. (BRIT.)

Agalinis filicaulis (Benth.) Pennell is also found in the coastal plain from Georgia westward to southwestern Louisiana (Godfrey & Wooten 1981; Vincent 1982). It is listed as an S1 species by the Louisiana Natural Heritage Program (Louisiana Natural Heritage Program 1999). Until recently, only one record of this species was known west of the Mississippi River in Allen parish (Vincent 1982; Thomas & Allen 1998; Louisiana Natural Heritage Program 1999). One

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new record in Beauregard Parish and a collection from Vernon Parish previously reported in Thomas and Allen (1998) extend the range of this species. The Vernon Parish specimen was found on the edge of a nearly level pitcher plant bog, while the Beauregard Parish specimen was found in a wet open pine savannah. Both of these areas are burned frequently and have a predominately herbaceous understory. This species should be looked for in similar habitats in eastern Texas.

Voucher specimens: **LOUISIANA. Beauregard Parish:** in a wet pine savannah in RCW cluster 6230A approximately 4 mi E of Singer, 30.637805° N and 93.342741° W, 30 Oct 2001, *Keith 26* (BRIT). **Vernon Parish:** edge of pitcher plant bog, 2.5 mi ESE of Fort Polk in Fort Polk Intensive Use Area, 18 Sep 1997, *Keith s.n.* (NLU).

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Rodgers (1950), Watson (1982), Johnston (1990), Texas Natural Heritage Program (1995), Jones et al. (1997), and Kartesz and Meacham (1999) include *Oxypolis ternata* (Nutt.) A. Heller in the Texas flora, apparently on the basis of a 1947 Lincoln Constance annotation of a 1945 V.L. Cory specimen (*Cory 49902* [GH]) from Hardin County that was identified initially as *Cynosciadium digitatum* DC. The Constance annotation reads: "?*Oxypolis ternata*." This apparently led Rodgers (1950) to include *O. ternata* in the Texas flora (Rodgers did not annotate *Cory 49902*) and Watson later (see Johnston 1990:57) to include it in her Big Thicket National Preserve plant list from which it has subsequently been copied by others. A search of Watson's vouchers revealed no *Oxypolis ternata* (Brown n.d.).

We examined *Cory 49902* and a duplicate at BRIT and found them to be narrow leaved *O. rigidior* (L.) Raf., which is a common morphological variant of that species over much of its range. Both specimens have paired leaflets and reticulate veins, characters of *O. rigidior* but not of *O. ternata*. Another troublesome Texas specimen has been *Correll 34924* [TEX] collected in Angelina Co. in 1967 and annotated to *O. ternata* by A.O. Tucker in 1980. It was annotated to *O. rigidior* by B.L. Turner in 2000 and reconfirmed to be *O. rigidior* by Tom Wendt (pers. comm.) in 2003. We also examined the Mathias and Constance (1961) treatment of Texas Apiaceae and found that they listed *Cory 49902* as an example of *O. rigidior* but did not mention *O. ternata* as occurring in Texas. A search of ASTC, BRIT, DUKE, F, FLAS, FSU, NCU, SBSC, SHST, TAMU (on line), TEX, and VDB revealed no Texas specimens of *O. ternata*. We have collected specimens of *O. rigidior* from Tyler County, adjacent to Hardin County, that are almost identical in appearance to *Cory 49902*. These have been deposited at TEX.

As far as we can discern, *O. ternata* occurs no closer to Texas than the cen-

tral Florida panhandle (Wunderlin 1998; Florida Atlas of Vascular Plants [www.plantatlas.usf.edu]).

ACKNOWLEDGMENTS

Bill Carr and Jason Singhurst, the Texas Parks and Wildlife Department, and the curators and staff of the herbaria where we worked, all aided with the study. Tom Wendt and Lindsay Woodruff examined a specimen at TEX.

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ANOTHER JUNIPER (CUPRESSACEAE) IN JEFF DAVIS COUNTY TEXAS? WE'RE NOT CONVINCED

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Within volume twenty, number two, of this journal, Griffith and Bartel (2002) answered our request (Karges & Zech 2001) for further study and documentation of *Cupressus arizonica* within the Davis Mountains of Jeff Davis County, Texas. While the effort has been made, we found several problems with the attempt, including the main points of concern that follow. Of the three additional specimens sampled from Jeff Davis County there is no indication that any were collected from the Davis Mountains, let alone the Davis Mountains Preserve (DMP). We're puzzled as to why fresh material of the Jeff Davis County *C. arizonica* or *Juniperus deppeana* from the DMP were not included for chloroplast DNA analysis. Both would have been made available upon request. Griffith and Bartel (2002) cite two specimens of the Jeff Davis County *C. arizonica*. *Karges and Hedges 2480* is the only existing specimen, a second specimen, *Karges s.n.*, was never collected. Griffith and Bartel's (2002) reference to, and discussion of, a mixed specimen is most puzzling, since neither Hedges (pers. comm.) nor Karges collected reproductive material.

Perhaps the chloroplast DNA data does suggest that the Jeff Davis County Arizona Cypress is Alligator Juniper. However, this study's discrepancies, along with the admittedly low 63% bootstrap, leave us unconvinced. We still recognize the tree in question as *C. arizonica*, and most importantly, continue to encourage additional, careful, study of this unique tree.

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BOOK NOTICES

DAVID H. GIBSON. Introduction by JOHN B. ROHRBACH. 2002. **Canyonland Vision: The Colorado Plateau of Southeast Utah.** (ISBN 0-57441-156-X, hbk.). Waterous & Co. (Orders: Folio Gallery Inc., 4404-15th Street S.W. Calgary, Alberta T2T 4B2, CANADA). Price not given, introduction, 44 b/w photos (six-by-seventeen-centimeter negative), 14" × 10".

The dust jacket notes, "*Canyonland Vision: The Colorado Plateau of Southeast Utah* captures the sweeping majesty of the harsh but poetic canyons of the American Southwest. John Rohrbach, Associate Curator of Photographs at the Amon Carter Museum in Fort Worth, Texas, provides an insightful introduction to Gibson's work."

The response I received after showing this book to a colleague was, "wow is this Ansel Adams"? No, this is David Gibson of Dallas, Texas and he loves nature and photography It's easy to see that David loves nature by looking at these magnificent photographs done in panoramic format. I can just stare at them endlessly. There are pics that include aspens, cottonwoods, Chamisa, ancient pines, etc.

The breathtaking photographs will stir your soul and your sense of wonder. I can't help but remember the quote by *J.B.S. Haldane*, "The world will not perish for want of wonders, but for want of wonder." The Colorado Plateau of southeast Utah is filled with beautiful and inspiring wonders. When you look at David Gibson's photographs in *Canyonland Vision* you will be filled with "wonder." I wonder how he did it! I wonder when I will get to see these poetic canyons myself. Soon I hope!—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

CHRISTOPHER T. MARTINE. Illustrated by RACHEL A. FIGLEY. 2002. **Shrubs and Vines of New Jersey.** (No ISBN, pbk. spiral bound). New Jersey Forest Service, Forest Resource Education Center, 370 E. Veterans Highway, Route 527, Jackson, NJ 08527, U.S.A. (Orders: 908-928-0987, njfsfrec@bellatlantic.net, www.state.nj.us/dep/forestry, check payable to NJ Forest Service). $10.00, 114 pp., line drawings, maps, 4 1/2" × 10".

This is a nice pocket guide to the shrubs and vines of New Jersey. Each taxon comes with an illustration and includes information on common name, Latin name, family, other names [common], wetland indicator status, NJ status, habitat and range; descriptive information is given on the leaves, stems, flowers, and fruit Where a species might be confused with other taxa, a general discussion is provided on similar species.

A ROCKHOUSE MICROHABITAT IN THE WEST CROSS TIMBERS OF NORTH CENTRAL TEXAS

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ABSTRACT

A rockhouse microhabitat located in the xeric savannah/woodland community of the West Cross Timbers of North Central Texas is discussed and an associated disjunct population of *Arisaema triphyllum* is reported.

RESUMEN

Se discute un microhábitat rocoso en la comunidad sabana/arbolado de West Cross Timbers en el centro-norte de Texas y se cita una población disyunta asociada de *Arisaema triphyllum*.

"Rockhouses" or rockhouse cliff formations are deep recesses in bedrock cliffs that can maintain microhabitats that are highly buffered from the extremes in temperature and moisture typical of the surrounding macroenvironment (Farrar 1998). As discussed by Walck et al. (1996), in comparison with the outside macroenvironment, rockhouse habitats tend to be more shaded, have higher temperatures during the winter, lower temperatures during the summer, and have lower rates of evaporation and higher relative humidities. Not only is there less evaporation, but water often enters via groundwater seepage, in some cases providing a relatively stable supply of moisture. In addition, condensation on the rock walls further increases humidity locally. The result is a rockhouse can provide microclimatic conditions very different (more moderated) from those typically found in a given geographic area.

There are numerous such rockhouse habitats in various areas of the eastern United States, particularly in sandstone strata. Several recent papers (Walck et al. 1996; Farrar 1998) have discussed these rockhouses and the interesting plant taxa now known to occur in them. According to Walck et al. (1996), 11 plant taxa are endemic or nearly endemic to sandstone rockhouses in the eastern U.S. Particularly interesting is the occurrence in rockhouses of a number of bryophytes and ferns with tropical affinities (Farrar 1998).

While relatively common in the eastern U.S., such rockhouse environments seem unlikely in the West Cross Timbers of North Central Texas—particularly

since hard surface rocks are unusual in most of the region. Such rocks, however, can be found in the area known as the Palo Pinto Country in the northwestern portion of the West Cross Timbers. This rather rugged region is underlain by the oldest rocks exposed in North Central Texas, deposited during the Pennsylvanian Period. These rocks vary, but are "largely made up of soft, impure shales alternating with harder, coarse, brown sandstone and conglomerates" (Hill 1901). In one area of western Parker County, where Pennsylvanian sandstones/conglomerates are exposed, deep recesses have formed that are worthy of the term rockhouse. Striking rock walls approximately 40 feet (12 meters) tall form narrow passageways and recesses. It has been known for a number of years that one unusual plant distributional record is associated with this environment. *Carya ovata* (Mill.) K. Koch, shag-bark hickory (Juglandaceae), is disjunct to this area by about 100 miles (275 kilometers) from its main region of occurrence in East Texas (e.g., *Lipscomb 2321*, 1977—BRIT). The site is also the westernmost locality in Texas for *Asplenium platyneuron* (L.) Britton, Sterns, & Poggenb., ebony spleenwort (Aspleniaceae) (Turner et al. 2003).

The moderated microclimate of this sheltered rockhouse microhabitat stands in rather sharp contrast to the macroclimate of the exposed upland West Cross Timbers macrohabitat/community. While yearly average precipitation in the area is approximately 29 inches (74 cm) (Griffiths & Orton 1968; Hatch et al. 1990), rainfall is unevenly distributed with summers typically being extremely hot and dry. As a result, the upland vegetation has a distinctly dry area aspect—a savannah/woodland with stunted *Quercus stellata* (post oak) and *Quercus marilandica* (blackjack oak), an understory of grasses (Diggs et al. 1999), and even such xerophytic, mainly western species as *Berberis trifoliolata* Moric. (agarito), *Echinocereus reichenbachii* (Terscheck ex Walp.) F. Haage (lace cactus), *Juniperus ashei* J. Buchholz (mountain-cedar), *Mimosa borealis* A. Gray (catclaw), *Opuntia leptocaulis* DC. (pencil cholla), *Zanthoxylum hirsutum* Buckley (prickly-ash), and *Ziziphus obtusifolia* (Hook. ex. Torr. & A. Gray.) A. Gray (lotebush).

Several years ago, another disjunction was discovered by one of us (O'Kennon). A large population of *Arisaema triphyllum* (L.) Schott, jack-in-the-pulpit (Araceae), was found in the mesic microhabitat between rock walls (Figs. 1 and 2) in the same extensive rockhouse as *Carya ovata* (voucher: *O'Kennon 16024*—BRIT). Interestingly, even though we estimate the population at approximately 2,000 above ground stems (the number of genetically distinct individuals is unknown), it had not been reported previously in the literature, possibly due to confusion with the related widespread species, *Arisaema dracontium* (L.) Schott, (green-dragon). The locality information was provided to Turner et al. (2003) for inclusion in the *Atlas of the Vascular Plants of Texas*. The large numbers of individual stems present and their occurrence through a rather extensive area of the rockhouse argues against any type of recent human interven-



FIG. 1. Rockhouse habitat in Parker Co., Texas with large number of individuals of *Arisaema triphyllum* in the foreground (photo by R.J. O'Kennon).

tion (e.g., transplantation). Observation of the population over two growing seasons revealed that relatively few plants produce inflorescences (roughly one in 100 during the first week of April), even fewer produce fruits (during one season only three individuals were observed with mature fruits), and most reproduction is probably by vegetation means. At the site, digging indicated that rhizomes/underground stolons could be traced between different stems signifying vegetative expansion of the population. Additionally, several transplanted plants produced offsets (traceable to the original plant) the following spring approximately 40–50 cm from the parent plants. It thus seems clear that the plants are reproducing vegetatively, and that the number of genetically different individuals probably can be determined only by molecular analyses. The apparent lack of extensive sexual reproduction is interesting in light of Kral's (1966) observation that other relict species in East Texas were also apparently reproducing predominantly via vegetative means. The disjunction between the western Parker County site and the nearest known East Texas location (Henderson County) is approximately 140 miles (225 kilometers). The occurrence of this species in the West Cross Timbers is quite unexpected given its preference for low or moist woods. However, the special microclimate (particularly reduced evapotranspiration and persistent substrate moisture) apparently has allowed the long term survival of this mesic species in an otherwise rather inhospitable macroenvironment.

The taxonomy of *Arisaema triphyllum* is controversial. Detailed study of these extremely variable plants led Huttleston (1949, 1981, 1984) to conclude that the variation seen in the species was best represented by recognizing a single species with four subspecies; he indicated that "...plants of the four subspecies are very distinctive and readily identified, at least in living condition. Since many of the key characteristics...are obscured or lost during drying, it is not always possible to identify herbarium specimens to subspecies." At the other taxonomic extreme, because "much overlap occurs in expression of the characteristics supposedly defining infraspecific taxa," because numerous intermediate forms exist, and because the ranges of the subspecies overlap, Thompson (2000) recently recognized a single variable species without infraspecific taxa. Thus, depending upon one's treatment of the variation present, the disjunct Parker County population would be either *Arisaema triphyllum* (no subspecies recognized) or *A. triphyllum* subsp. *triphyllum*. In a forthcoming flora of East Texas, we are treating the taxon as *A. triphyllum* subsp. *triphyllum*.

As discussed by Kral (1966), MacRoberts and MacRoberts (1997), and others, Texas has numerous plant occurrences which represent relicts of past climatic conditions. Further, from the study of Texas bogs (e.g., Potzger & Tharp 1954; Bryant 1977; Holloway & Bryant 1984; Bryant & Holloway 1985) and from knowledge of modern day plant distributions (e.g., Turner et al. 2003), it is clear



FIG. 2. Closeup of *Arisaema triphyllum* (photo by R.J. O'Kennon).

that Texas vegetation was profoundly influenced by the climatic change associated with glaciation, even though actual glaciers were hundreds of miles to the north of Texas. The Parker County occurrence of *Arisaema triphyllum* thus probably represents an "Ice Age holdover" (MacRoberts & MacRoberts 1997) from a colder and wetter period of the Pleistocene when vegetational areas were shifted considerably to the south and west. It is known, for example, that at 15,000 years before present, the mean annual air temperature of Texas was 5° C less than at present, conditions were moister, and there was a more widespread forest mosaic over most of Texas (Bryant 1977; Stahle & Cleaveland 1995). Other modern day reflections of such past conditions can be seen in the many species and genera typical of East Texas showing up in isolated disjunct pockets on the Edwards Plateau (e.g. *Hamamelis virginiana* L., witch-hazel) as well as many other interesting disjunct species and communities (Palmer 1920; Diggs 2002).

While rare in Texas, rockhouses do provide an interesting window into biogeographic history. As noted by Farrar (1998), the disjunct occurrences of plant species in rockhouses "document, as clearly as do fossils, a record of changing climate and vegetation." When this phenomenon is taken together with the study of bogs, and an understanding of other current day plant distributions, the impact of glacial history on the vegetation of Texas becomes increasingly understandable.

ACKNOWLEDGMENTS

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BOOKS FROM UNIVERSITY OF NORTH TEXAS PRESS

CAMPBELL and LYNN LOUGHMILLER (Compilers & Editors). Foreword by FRANCIS E. ABERNETHY. 2002. **Big Thicket Legacy.** (ISBN 0-57441-156-X, hbk.). University of North Texas Press, PO Box 311336, Denton, TX 76203-1336, U.S.A. (Orders: 940-565-2142, fax 940-565-4590, rchrisman@unt.edu, www.unt.edu/untpress). $14.95, 256 pp., 42 b/w photos, 1 map, 7" × 10".

This book was first published in 1977 and this paper back printing brings this classic on Big Thicket history back into print. Key Words: Texas, Big Thicket (Texas), folklore, natural history.

GERALDINE ELLIS WATSON. 2003. **Reflections on the Neches: A Naturalist's Odyssey Along the Big Thicket's Snow River.** (ISBN 1-57441-160-8, hbk.). University of North Texas Press, PO Box 311336, Denton, TX 76203-1336, U.S.A. (Orders: 940-565-2142, fax 940-565-4590, rchrisman@unt.edu, www.unt.edu/untpress). $14.95, 256 pp., 11 b/w photos, 29 drawings, 20 maps, 7" × 10".

If there was ever a dust jacket that made you want to open up a book it is the one on this book. It pictures the glorious bald cypress (*Taxodium distichum*) with its stunning buttress-like trunks, reflecting on the Neches River. This book is a reflection of Geraldine Watson and her love of nature, East Texas, the Neches River, and the Big Thicket. "The book is a series of essays about a river and its environment, and the kind of people such environs produce, which includes myself."

Geraldine Watson, botanist, plant ecologist, naturalist, and conservationist, was one of several people instrumental in raising attention and serving as a national conscience to save at least some thing of the Big Thicket in East Texas. Thank you Geraldine for your hard work and for giving us a book full of history and memories! Thanks to the T.L.L. Temple Foundation for a generous grant to help publish the book and to the Big Thicket Association for their assistance —*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

WILLIAM DEAN REESE

(1928–2002)

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William Dean Reese, 'Bill' to family members and his many friends, died, age 73, on 4 February 2002 in Lafayette, Louisiana after a short battle with cancer.

Bill was born in Baltimore, Maryland on 10 September 1928. His formative years were spent on a dairy farm, and as a result he always considered himself a 'farm boy at heart.' Perhaps as a result of his experiences on the farm Bill had a practical approach to life and an unquenchable appreciation for nature. This view never left him. Bill strived to pass this view on to his children and grandchildren. Realizing that his children and grandchildren would never experience the joys of farm life he decided to record memories of his years on the farm, primarily for their benefit. These memories were privately published in 1997 as *Lone Hickory. Reminiscences from the Reese Farm at Gwynnbrook, Maryland, 1930s-1940s*, with corrections made in 1998.

Bill enrolled in the University of Maryland in 1945, but his undergraduate studies were interrupted by two tours in the United States Army. In 1946–48, as a member of the Signal Corps, he was stationed in the Philippines; between 1950–51 he was a cook in Fort Hood, Texas. Bill's great love of cooking (and eating!) good food was perhaps initiated by this experience. In 1953 Bill was graduated from the University of Maryland with a B.S. in Botany. It was during his undergraduate studies that Bill's interest in bryophytes was piqued. In one of his biological science laboratories Bill observed the release of living antherozoids from moss antheridia, an observation that led to his second bryological publication, *On observing bryophyte antherozoids* (Bryologist 58:335–336. 1955). In the Fall of 1953 Bill began graduate studies in bryology at Florida State University under Dr. Ruth S. Breen, graduating with an M.S. in Botany in 1955 and a Ph.D. in Botany in 1957.

Upon graduation, Bill was offered and accepted an appointment as Assistant Professor of Biology at The University of Southwestern Louisiana (now The University of Louisiana at Lafayette). He remained at this university throughout his 30-year professional career, advancing to Associate Professor (1962) and Professor (1966). Bill was an outstanding teacher and served as primary advisor to 11 graduate students. In 1970 he was named *University of Southwest Louisi-*

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WILLIAM DEAN REESE
(1928–2002)

ana Foundation Distinguished Professor. Upon his retirement in 1987 the University appointed him *Edwin L. Stephens Honor Professor Emeritus*, an appointment he held until his death. In addition to his teaching responsibilities, Bill served the University and Biology Department as an able administrator: Chairman of the Biology Department (1974–77) and Department Head (1981–86).

Bill was a towering figure in American bryology. His primary interest centered on the tropical/subtropical family Calymperaceae. His studies on this family began with his Ph.D. dissertation and continued for the remainder of his life. Never tiring of these mosses, he delved into their systematics and phylogeny, the evolution and functional morphology of their asexual reproduction, and the evolution of their niche specificity. At his death he left an incomplete manuscript, *Fertility in Calymperaceae: Calymperes, Mitthyridium and Syrrhopodon*. Bill's interest in bryology, however, was not limited to the Calymeraceae. He was also a superb floristic bryologist with particular interest in the mosses of the southern United States. His book *Mosses of the Gulf Coast*, which treats the species from the Rio Grande (southern Texas) to the Apalachicola River (western Florida), is the standard floristic work for that region.

Throughout his career, Bill had a total of 154 bryological publications.

Bill was a consummate botanist. Although his principal interests lay in bryology, Bill was an acknowledged authority on the taxonomy of vascular plants. He took great delight in showing visitors the many interesting native flowering plants he had transplanted around his home. His professional interest in vascular plants led to the publication of several papers as well as the book *Acadiana Flora. Native and Naturalized Woody Plants of South-Central Louisiana*, completed with his long-time colleague at the university, Garrie Landry. At the time of his death he was working on another book., *Mamou: Acadian Folklore, Natural History, and Botany of Erythrina herbacea L.*, with Charles Allen, a former graduate student. Away from botany, he had considerable knowledge of fungi, particularly the basidiomycetes, and was an avid ornithologist, delighting in pointing out to visitors the many spectacular birds native to southern Louisiana.

Bill and a colleague, John Thieret, were the first (and only) botanists to complete an exhaustive survey of the vascular flora of the five 'salt domes' [Bell Island, Cote Blanche Island (accessible only by boat), Weeks Island, Avery Island, and Jefferson Island] located along the Louisiana coast. The results of this survey were published as *Botanical Study of the Five Islands of Louisiana*. Bill was immensely proud of his part in this exploratory work and continued to revisit the accessible areas long after the survey was completed.

Bill found great enjoyment in field work. Collecting specimens of bryophytes and vascular plants was one of his great pleasures and greatly enhanced his research. In addition to collecting extensively in North America he also participated in expeditions to Mexico, the Amazon Basin in South America, the

West Indies, Australia, and China. His earliest recorded collection, a specimen of *Quercus falcata* Michx., was made just outside Tallahassee, Flordia in August 1955, and his last identified collection (*Reese 18,593*), *Pseudoleskeella tectorum* (Brid.) Kindb., was made in Otero County, New Mexico on 15 June 2000. These collections (numbering about 35,000 specimens) are now in MO and are available for study. Eventually the collections will be intercalated in the Crosby Bryophyte Herbarium (MO). Record books and journals are also on file at MO.

In addition to his duties as teacher, researcher and administrator, Bill was an exceptional editor. Although he was exacting and had little patience with foolishness, he balanced his criticisms with encouragement and insightful comments, a reflection of his quiet and even nature. When a manuscript was returned by Bill one could be certain that it was considerably improved, regardless of how many times it had been edited previously. Bill was twice Editor of The Bryologist (1970–74; 1988–1995), and Associate Editor of The Bryologist (1977–1980), and an editor for and an unwavering supporter of the *Bryophyte Flora of North America* project, for which before his death he completed manuscripts in the Brachytheciaceae, Calymperaceae, Cryphaeaceae, Hypnaceae, Leucodontaceae, Leucophanaceae, Meteoriaceae, Pterobryaceae, Ptychomitriaceae, Racopilaceae, and Splachnobryaceae.

Bill served The American Bryological and Lichenological Society as Secretary-Treasurer (1969–1970), Vice-President (1977–1979), and President (1979–1981). In addition, Bill was a member of the American Association for the Advancement of Science, Association of Southeastern Biologists, British Bryological Society, International Association of Bryologists, International Association for Plant Taxonomy, Nordisk Bryologisk Forening, Sociedad Latinamericano de Briología, Society of the Sigma Xi, and a charter member of the Hedwigian Society (Missouri Botanical Garden). In 1988 he was appointed a Research Associate by the Missouri Botanical Garden.

Bill is survived by his wife, Lorelle, two daughters, Jean Harvill and Christine Proctor, twin sons, David and William, and five grandsons.

Bryology has lost one of its pre-eminent students, his family a loving and wonderful husband, father and grandfather, and those of us who knew him well, a faithful and loyal friend.

The tribute to Bill published in Bryologist 105(4):625–634. 2002 [2003] includes a list of taxa associated with Bill, and a bibliography of his botanical publications.

BOOK REVIEW

JOHN F. NUNN. 2002. **Ancient Egyptian Medicine.** (ISBN 0-8061-3504-2, pbk.) (Orders: University of Oklahoma Press, 4100 28th Avenue, Norman, OK 73069-8218; www.oupress.com, 405-307-9048 fax). $29.95, 240 pp, 45 b/w illustrations, 32 tables, 1 map, 7" × 10".

When one considers the topic of Egyptology, the thoughts which arise are sure to concern themselves with the elaborate tombs and pyramids that can be found in any picture guide to the Ancient Egyptians; although this is an important facet of study, it allows other, more subtle aspects of the culture to be ignored. Within the 240 pages of his work, John Nunn presents a comprehensive, yet detailed, account of one of the lesser studied topics within Ancient Egyptian culture: medicine. Nunn carries the reader from a brief background of the aspects of Egyptian culture influencing their medical practice to studies of their healers, drug therapies and to their more specialized branches. Approaching the subject as a retired anesthesiologist as well as an Egyptologist, Nunn is in a unique position to act as an authority on the merging of these two subjects.

The book begins with a brief geographical and historical placement of the Ancient Egyptians, establishing the "unique environment in which their medical practice could be developed and recorded" by means of discussion of methods of food production, nutritional state, life expectancy, writing, etc. The primary concern of this first chapter is to set the stage and the background for the reader to be able to follow the remainder of the book. After establishing that the culture had the leisure to engage in activities other than defense and food production, the discussion moves to the primary source of the claims Nunn makes, the medical papyri.

Through an extensive compilation and investigation of various surviving medical texts written on papyrus (*Cyperus papyrus*), Nunn reaches his conclusions about the medical practice of the Ancient Egyptians while also acknowledging the difficulties of translation. Other important sources of information used in the investigation include human remains and artistic renditions of the disease state. In particular, the embalming techniques and environmental conditions (a dry and hot climate) of the region acted to preserve the human remains in excellent detail (causing them to desiccate faster than they would putrefy). There is a conscious effort made to avoid the pitfalls of validating the past in terms of modern concepts, while yet highlighting the fact that certain medical procedures practices by the Egyptians are in fact up to modern standards.

The remaining chapters carry the topics mentioned at the beginning to deeper levels; for example, carrying the topic of the patterns of disease, to intricate discussions about such things as parasitic, viral and bacterial diseases, deformities, and ageing processes. Furthermore the book is littered with documented studies regarding each topic, thus also serving as a reference to further reading on the particular topics. The readers will chuckle as they read the various treatments for disease states, such as those found within the chapter on specialized medical branches. Regarding sex determination during pregnancy: "Emmer (*bedet*) and barley (*it*), the lady should moisten with her urine every day, like dates and like sand in two bags. If they all grow, she will bear a child. If the barley grows, it means a male. If the emmer grows, it means a female. If they do not grow, she will not bear a child." The interesting aspect about this case is the unusual findings Nunn documents of studies done in 1963 by Ghalioungui et al., testing the treatment.

The format of the book is quite easy to follow, it increases in complexity as the reader's background is established, and where a subject is touched upon that will later be clarified, the location is specified. Although there are no color illustrations, those few well-chosen diagrams clarify the concepts dealt with in the text. The many tables are quite comprehensive and include those dealing with herbal remedies of certain, less certain and uncertain origin, as well as 29 others. While it is unlikely

that the majority of readers will be able to follow the entire book with complete understanding, the discussions are all sufficiently in-depth to maintain a specialist's interest while also maintaining that of a reader new to the field.

While the information contained within this 2002 work is merely a reprint of the 1996 cloth publication, the improved presentation of the material makes it less liable to being overlooked The book manages to bridge a gap in its particular field, building and improving upon other publications which have at best been incomplete and muddling. Nunn has presented a concise and well-rounded approach to the study of medicine in Ancient Egyptian culture, which will leave both the merely interested reader and the avid scholar, fully satisfied.—*Tiana Francesca Franklin, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX, 76102,4060, U.S.A., tianaff@hotmail.com.*

NEW BOOKS

David Pimentel (Editor). 2002. **Biological Invasions: Economic and Environmental Costs of Alien Plant, Animal, and Microbe Species.** (ISBN 0-8493-0836-4, hbk.). CRC Press LLC, 2000 N.W. Corporate Blvd., PO Box 31225, Boca Raton, FL 33431, U.S.A. (Orders: 800-272-7737, fax 800-374-3401; Canada & International 561-994-0555, fax 561-989-8732, www.crcpress.com). Price not given, 369 pp., graphs/figs., 7" × 10".

Forty-five contributors provide detailed information on components of the invasive-species problem from six continents. The book is divided into nine sections: **I** Introduction; **II** Australia; **III** Brazil; **IV** British Isles; **V** India; **VI** New Zealand; **VII** South Africa; **VIII** United States; **IX** World Overview. The book is informative and will serve "scientists, policymakers, and the public on the seriousness of non-native species invasions, which can cause extinctions and significant costs to the environment, economy, and public health."

Eric T. Jones, Rebecca J. McLain, and James Weigand (Editors). 2002. **Nontimber Forest Products in the United States.** (ISBN 0-7006-1165-7, pbk.). University Press of Kansas, 2501 West 15th Street, Lawrence, KS 66049, U.S.A. (Orders: 785-864-4154, fax 785-864-4586, www.kansaspress.ku.edu). $29.95, 445 pp., 2 figures, 6" × 9".

From press release: "*Nontimber Forest Products in the United States* provides the first comprehensive examination of these abundant resources throughout the United States, illustrating nontimber forest products' diverse importance, describing the people who harvest them, and outlining the steps that are being taken to ensure access to them."

Duane A. Smith. 2002. **Mesa Verde National Park: Shadows of the Centuries, Revised Edition.** (ISBN 0-87081-684-5, pbk.). University Press Colorado, 5589 Araphoe Road, Suite 206C, Boulder, CO 80303, U.S.A. (Orders: 720-406-8849, fax 720-406-3443). $14.95, 272 pp., 63 b/w photos, 2 maps, 6" × 9".

THE RUPERT BARNEBY AWARD

The New York Botanical Garden is pleased to announce that Jason Alexander, currently a graduate student in the Department of Botany & Plant Pathology, Oregon State University, is the recipient of the Rupert Barneby Award for the year 2003. Mr. Alexander will be studying the systematics of various species of *Astragalus* in the western United States.

The New York Botanical Garden now invites applications for the Rupert Barneby Award for the year 2004. The award of US$ 1,000.00 is to assist researchers to visit The New York Botanical Garden to study the rich collection of Leguminosae. Anyone interested in applying for the award should submit their curriculum vitae, a detailed letter describing the project for which the award is sought, and the names of 2-3 referees. Travel to the NYBG should be planned for sometime in the year 2004. The application should be addressed to Dr. James L. Luteyn, Institute of Systematic Botany, The New York Botanical Garden, 200th Street and Kazimiroff Blvd., Bronx, NY 10458-5126 USA, and received no later than December 1, 2003. Announcement of the recipient will be made by December 15.

Anyone interested in making a contribution to THE RUPERT BARNEBY FUND IN LEGUME SYSTEMATICS, which supports this award, may send their check, payable to The New York Botanical Garden, to Dr. Luteyn.

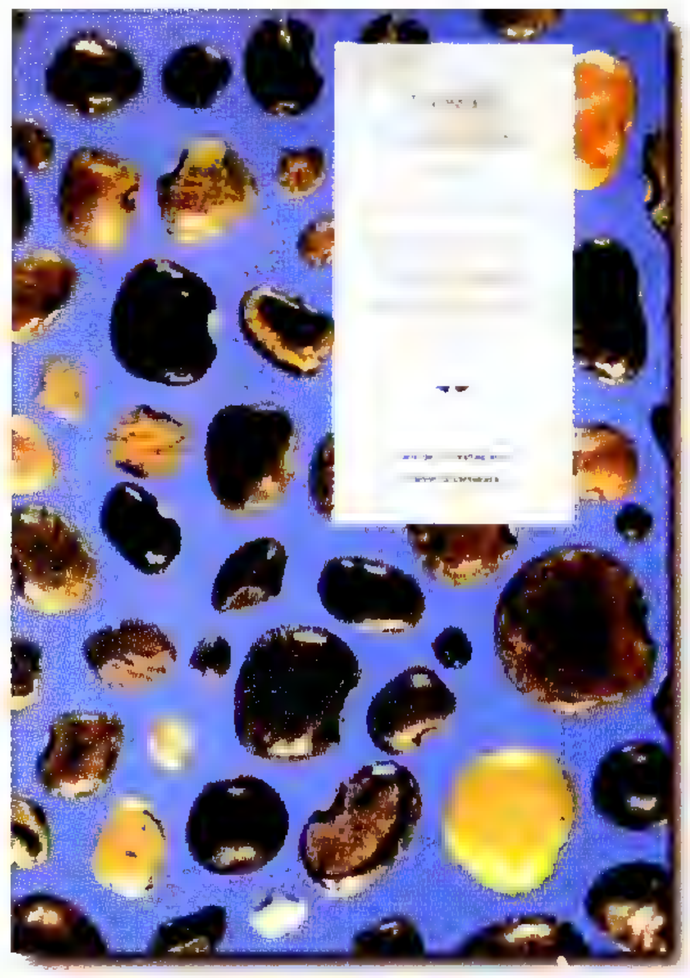
THE DELZIE DEMAREE TRAVEL AWARD

Graduate students in plant systematics are eligible to apply for the Delzie Demaree Travel Award, a $250.00 stipend to help defray expenses related to attendance at the Missouri Botanical Garden 50th Annual Systematics Symposium (10–11 Oct 2003). The 2003 symposium: Species Reconsidered: Consequences for Biodiversity and Evolution.

The application should include a letter from the applicant telling how symposium attendance will benefit his/her graduate work and letter of recommendation sent by the major professor. Please mail letters of application to: Dr. Donna M.E. Ware, Herbarium, Biology Department, The College of William and Mary, Williamsburg, VA 23185, U.S.A.

Anyone interested in making a contribution to Delzie Demaree Endowment Fund, which supports the travel award, may send their check, payable to Botanical Research Institute of Texas, to Barney Lipscomb, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A. Thank you.

This lavishly illustrated monograph is the most comprehensive botanical treatment of beans to date. It begins with a brief history about the former taxonomical treatments of the genus, and goes on with the taxonomical criteria and a presentation about discriminant characteristics. It presents a full description of each section and species, its distribution and habitat, relationships with other species, uses and potentially useful traits, and historical notes. Color pictures, line drawings, and distribution maps lead easily to the right identification of each species.



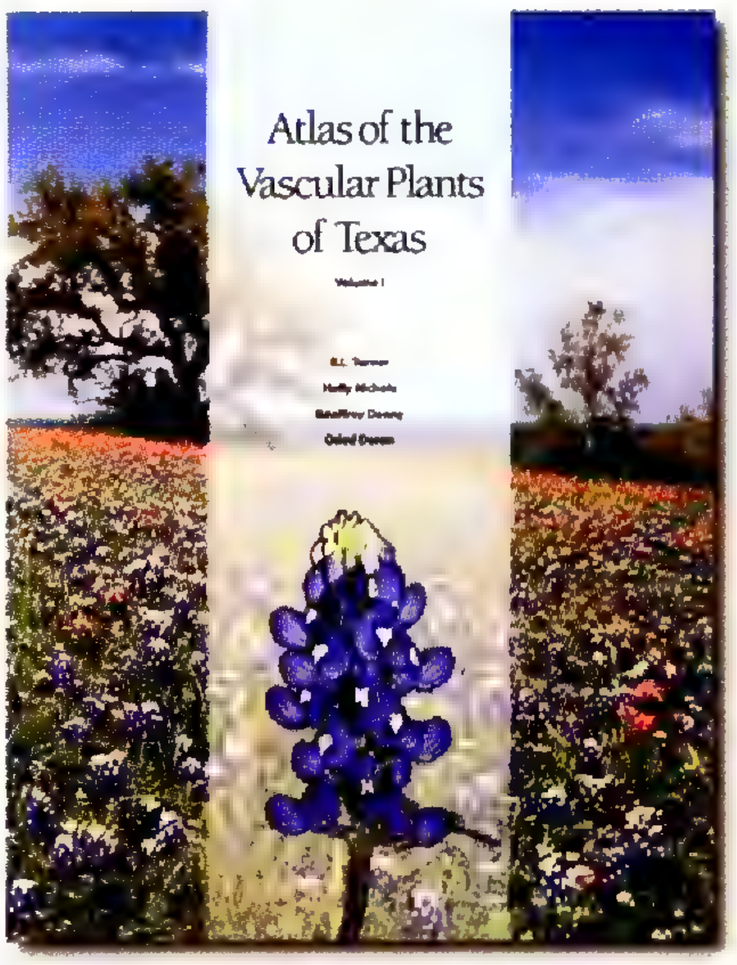
Taxonomy, Distribution, and Ecology of the Genus Phaseolus (Leguminosae–Papilionoideae) in North America, Mexico and Central America

By
George F. Freytag
Daniel G. Debouck

Available from
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Denny, Oded Doron

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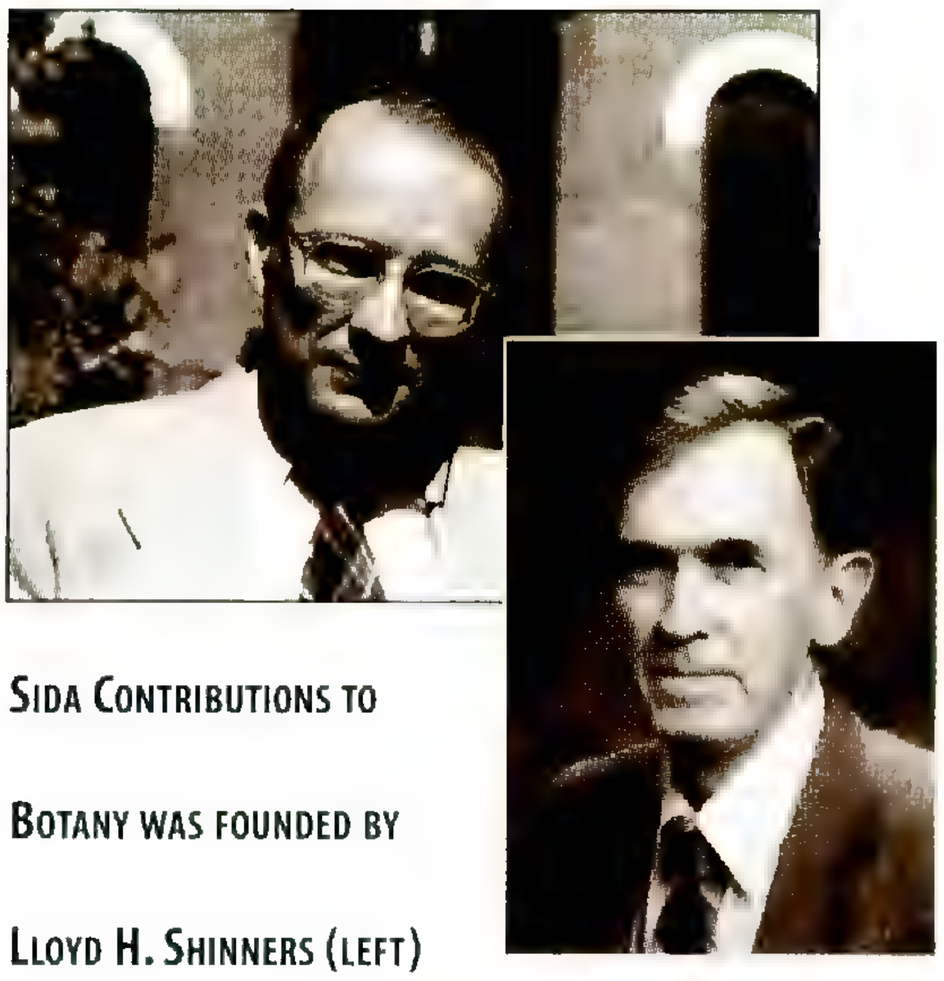
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Eurybia glauca var. **pulchra** (S.F. Blake) Brouillet, comb. et stat. nov.—**1562**

Gentianella boliviana (Pax) J.S. Pringle, comb. nov.—**1486**

Gentianella inaequicalyx (Gilg) Fabris ex J.S. Pringle, comb. nov.—**1488**

Glandularia verecunda forma **albida** (Moldenke) B.L. Turner, comb. nov.—**1648**

Ipomoea tacambarensis E. Carranza, sp. nov.—**1351**

Leandra urbaniana (Alain) Alain, comb. nov.—**1645**

Liatris patens Nesom & Kral, sp. nov. —**1579**

Liatris savannensis Kral & Nesom, sp. nov.—**1574**

Matelea monticola Alain, nom. nov. —**1645**

Maytenus urbanii Alain, nom. nov. —**1645**

Polygonum sawatchense subsp. **oblivium** Costea & Tardif, subsp. nov. —**1637**

Portulaca matthewsii G. Ocampo, sp. nov.—**1358**

Psidium salutare var. **decussatum** (DC.) Landrum, comb. nov.—**1463**

Psidium salutare var. **mucronatum** (Cambess.) Landrum, comb. nov. —**1463**

Psidium salutare var. **pohlianum** (O. Berg) Landrum, comb. nov.—**1466**

Psidium salutare var. **sericeum** (Cambess.) Landrum, comb. nov.—**1467**

Psychotria bulilimontis Takeuchi, sp. nov. —**1514**

Psychotria bulilimontis var. **aestuarii** Takeuchi, var. nov.—**1519**

Sagraea rugosa Alain, nom. nov.—**1645**

Solidago altissima subsp. **gilvocanescens** (Rydb.) J.C. Semple, comb. et stat. nov.—**1606**

Solidago arenicola B.R. Keener & Kral, sp. nov.—**1589**

Solidago ser. **Auriculatae** Semple, ser. nov. —**1606**

Solidago ser. **Drummondiani** Semple, ser. nov.—**1606**

Solidago faucibus Wieboldt, sp. nov. —**1596**

Solidago subsect. **Humiles** (Rydb.) Semple, comb. et stat. nov.—**1606**

Solidago kralii Semple, sp. nov.—**1606**

Solidago lepida subsp. **fallax** (Fernald) Semple, stat. nov.—**1611**

Solidago lepida var. **salebrosa** (Piper) J.C. Semple, comb. nov.—**1611**

Solidago subsect. **Multiradiatae** (Juz.) Semple, comb. nov.—**1605**

Solidago odora subsp. **chapmanii** (A. Gray) J.C. Semple, comb. nov. —**1611**

Solidago ser. **Odorae** (Mackenzie in Small) Semple, comb. et stat. nov. —**1606**

Solidago patula subsp. **strictula** (Torr. & A. Gray) J.C. Semple, stat. nov. —**1612**

Solidago puberula subsp. **pulverulenta** (Nutt.) J.C. Semple, comb. et stat. nov.—**1612**

Solidago rugosa var. **cronquistiana** Semple, var. nov.—**1612**

Solidago sempervirens subsp. **azorica** (Hochst. ex Seubert) Semple, comb. et stat. nov.—**1615**

Solidago sempervirens subsp. **mexicana** (L.) Semple, comb. et stat. nov. —**1615**

Solidago speciosa subsp. **pallida** (Porter) Semple, comb. et stat. nov.—**1615**

Solidago stricta subsp. **gracillima** (Torr. & A. Gray) Semple, comb. et stat. nov.—**1615**

Solidago velutina subsp. **californica** (Nutt.) Semple, comb. et stat. nov.—**1616**

Solidago velutina subsp. **sparsiflora** (A. Gray) Semple, comb. et stat. nov. —**1616**

Trichadenia sasae Takeuchi, sp. nov. —**1522**

Xanthisma arenarium (Benth.) D.R. Morgan & R.L. Hartman, comb. nov.—**1405**

Xanthisma blephariphyllum (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov.—**1403**

Xanthisma section **Blepharodon** (DC.) D.R. Morgan & R.L. Hartman, comb. nov.—**1401**

Xanthisma coloradoense (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov.—**1403**

Xanthisma crutchfieldii (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov.—**1403**

Xanthisma glaberrimum (Rydb.) Nesom & O'Kennon, comb. nov.—**1586**

Xanthisma gracile (Nutt.) D.R. Morgan & R.L. Hartman, comb. nov.—**1405**

Xanthisma grindelioides (Nutt.) D.R. Morgan & R.L. Hartman, comb. nov.—**1403**

Xanthisma grindelioides var. **depressum** (Maguire) D.R. Morgan & R.L. Hartman, comb. nov.—**1404**

Xanthisma gymnocephalum (DC.) D.R. Morgan & R.L. Hartman, comb. nov.—**1404**

Xanthisma gypsophilum (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov.—**1404**

Xanthisma section **Havardii** (R.C. Jackson) D.R. Morgan & R.L. Hartman, comb. nov.—**1410**

Xanthisma incisifolium (I.M. Johnston) Nesom, comb. nov.—**1585**

Xanthisma johnstonii (S.F. Blake) D.R. Morgan & R.L. Hartman, comb. nov.—**1404**

Xanthisma junceum (Greene) D.R. Morgan & R.L. Hartman, comb. nov. —**1406**

Xanthisma restiforme (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov.—**1405**

Xanthisma rhizomatum (M.C. Johnston) D.R. Morgan & R.L. Hartman, comb. nov.—**1405**

Xanthisma section **Sideranthus** (Nutt. ex Nees) D.R. Morgan & R.L. Hartman, comb. nov.—**1405**

Xanthisma spinulosum var. **chihuahuanum** (B.L. Turner & R.L. Hartman) D.R. Morgan & R.L. Hartman, comb. nov.—**1408**

Xanthisma spinulosum var. **glaberrimum** (Rydb.) D.R. Morgan & R.L. Hartman, comb. nov.—**1408**

Xanthisma spinulosum var. **gooddingii** (A. Nelson) D.R. Morgan & R.L. Hartman comb. nov.—**1408**

Xanthisma spinulosum var. **incisifolium** (I.M. Johnston) D.R. Morgan & R.L. Hartman, comb. nov.—**1409**

Xanthisma spinulosum var. **paradoxum** (B.L. Turner & R.L. Hartman) D.R. Morgan & R.L. Hartman, comb. nov.—**1409**

Xanthisma spinulosum var. **scabrellum** (Greene) D.R. Morgan & R.L. Hartman, comb. nov.—**1409**

Xanthisma spinulosum (Pursh) D.R. Morgan & R.L. Hartman, comb. nov.—**1406**

Xanthisma stenolobum (Greene) D.R. Morgan & R.L. Hartman, comb. nov.—**1409**

Xanthisma viscidum (Wooton & Standley) D.R. Morgan & R.L. Hartman, comb. nov.—**1410**

Xanthisma wigginsii (S.F. Blake) D.R. Morgan & R.L. Hartman, comb. nov.—**1409**

CASTILLEJA ALBOBARBATA SP. NOV. (OROBANCHACEAE) FROM SIERRAS MANANTLÁN AND CACOMA, JALISCO, MEXICO

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ABSTRACT

A new species, **Castilleja albobarbata** Iltis & Nesom, is described from localities in Sierra de Manantlán and Sierra Cacoma of Jalisco, México. It differs from *C. integrifolia* primarily in features of vestiture and is geographically disjunct from the nearest populations of *C. integrifolia* by about 450 kilometers.

KEY WORDS: *Castilleja*, Orobanchaceae, Scrophulariaceae, Sierra de Manantlán, Sierra Cacoma, Jalisco, México, biogeography, rare plants

RESUMEN

Se describe una especie nueva, **Castilleja albobarbata** Iltis & Nesom, de la Sierra de Manantlán y Sierra Cacoma de Jalisco, México. Se diferencia de *C. integrifolia* principalmente por las características del indumento y está separada geográficamente unos 450 kilómetros de la población más próxima de *C. integrifolia*.

Castilleja albobarbata Iltis & Nesom, sp. nov. (**Figs. 1–3**) TYPE: MÉXICO. JALISCO: Mpio. Cuautitlán, [Sierra de Manantlán Biosphere Reserve], top of sharp crest of the Sierra de Manantlán Oriental just E of Cerro Las Capillas, along highest point of gravel road from Cerro La Cumbre to Los Jardines, 19 km due SSE of El Chante (19° 33'19" N, 104° 09' W), cliffs of basaltic sandstone conglomerate, 2800–2860 m elev., 10 Oct 1980, *H.H. Iltis 3227 with R. Guzmán-M.* (HOLOTYPE: WIS; ISOTYPES: TEX, ZEA).

Castillejae integrifoliae L.f. similis sed vestimento trichomatibus brevissimis antrorse appressis et corollarum galea albobarbata differt.

Herbaceous perennials, usually with numerous (up to 15) erect to ascending or sprawling stems originating from the common base, the stems 2–4(–7) dm tall, basally woody, simple or few-branched in the upper half; stems, leaves, and bracts eglandular, moderately to sparsely invested with short (ca. 0.05–0.1 mm long), white, flattened, antrorsely ascending-appressed hairs. Leaves yellow-green, spreading to slightly deflexed, entire, not clasping or auriculate, those of the lower stems linear to narrowly lanceolate, 25–45 mm long, 2–4 mm wide,

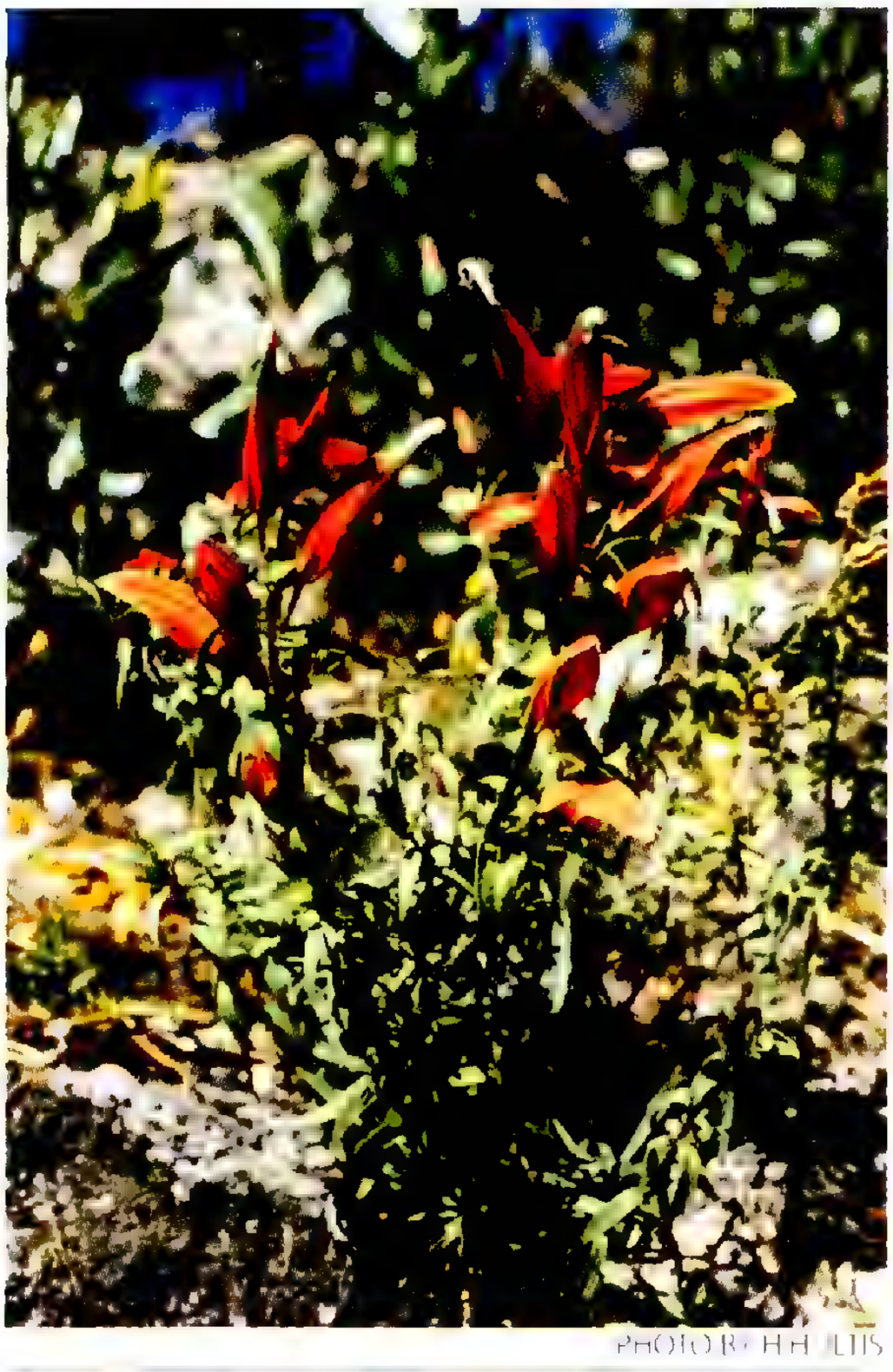


FIG. 1. Habit of *Castilleja albobarbata* (type collection).



FIG. 2. Flowers of *Castilleja albobarbata* (type collection).

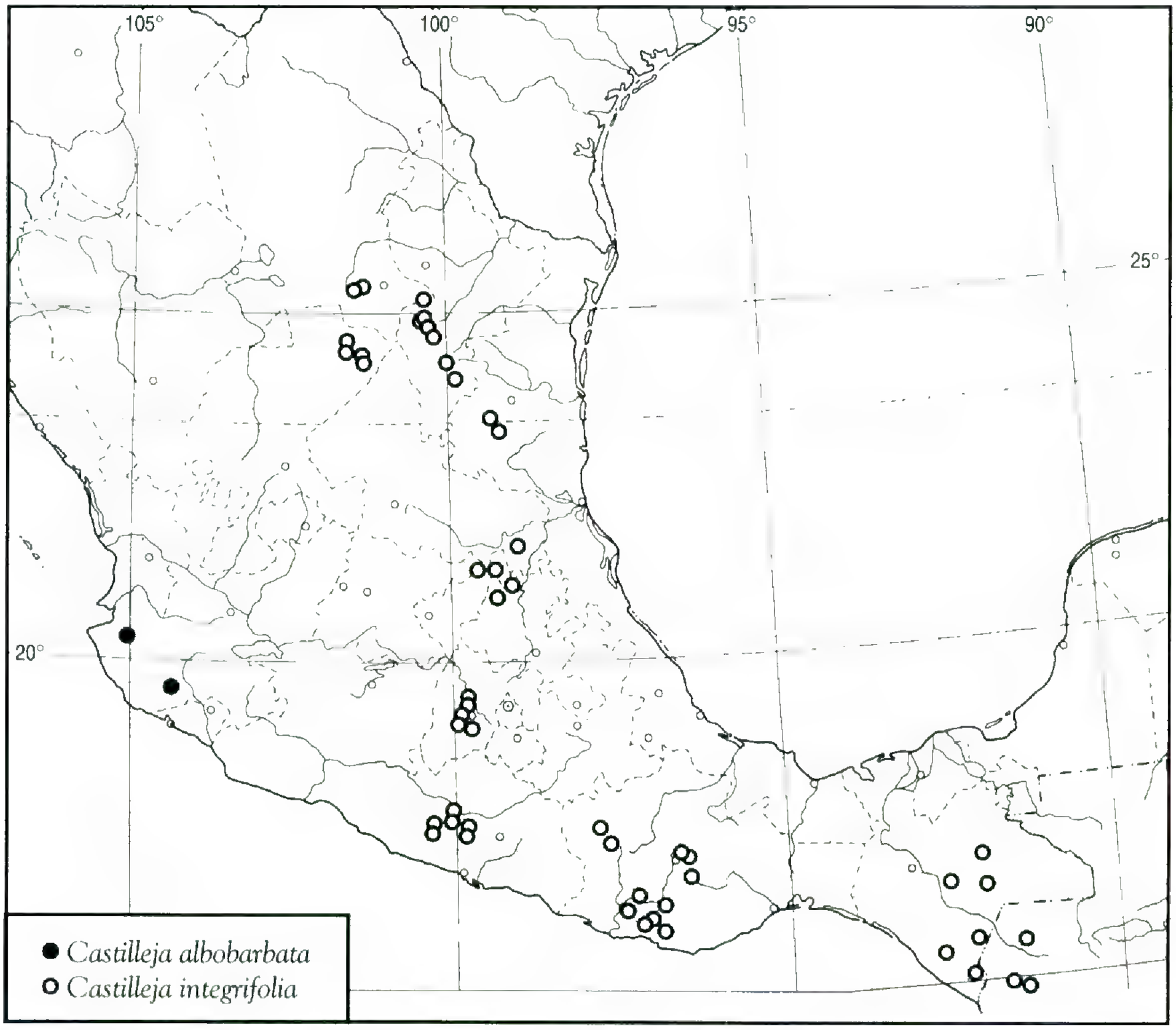


FIG. 3. Distributions of *Castilleja integrifolia* in Mexico and *C. albobarbata*. Modified after Nesom 1992.

becoming narrowly ovate-lanceolate near the inflorescence with a subclasping base and up to 6 mm wide, grading into the floral bracts. Floral bracts entire, lanceolate, 15–35 mm long, markedly enlarged from the uppermost leaves, the lower bracts completely green, the terminal persistent and conspicuous, markedly differentiated from the lower, red and obovate to widely ovate. Flowers in a racemose, somewhat secund inflorescence; pedicels 10–20 mm long, ascending; calyces 29–35 mm long, slightly gibbous abaxially, minutely hispid-strigose, brick-red with a yellow-green apical margin or sometimes yellow at the base, less commonly yellow-green throughout, the abaxial cleft 20–25 mm deep, the adaxial cleft 2–5 mm deep, the primary lobes with 2 short teeth or acute notches; corollas 40–45 mm long, the tube pale yellowish, becoming brick-red near the lower lip; the galea yellowish with red flanges, 25–27 mm long, 5/8–5/9 the length of the corolla, exserted (2–)7–15 mm from the calyx, producing a long (ca. 12 mm), densely pilose, adaxial, toothbrush-like beard of multicellular, white trichomes 2–3.5 mm long, the corolla otherwise glabrous, the lower lip composed of 3, small, thickened, greenish-yellow, incurved teeth 1–2 mm

long; stigma barely thickened, ca. 0.3 mm wide; anthers 2–2.5 mm long. Mature fruits not observed.

Additional collections examined: **MEXICO. Jalisco.** Mpio. Cuautitlán: Sierra de Manantlán, area of type collection near Cerro Las Capillas, pine woods with *Arbutus* and *Comarostaphylos*, 2800 m, 31 Aug 1986, *Cuevas 1617* (WIS) and 9 Jan 1980, *Iltis et al. 2507* (WIS, ZEA); Sierra de Manantlán, ca. 15 mi SSE of Autlán by way of Chante, rocky outcrops in cypress-pine forest, 8700 ft, 30 Jul 1949, *Wilbur and Wilbur 1989* (MICH, NY); Mpio. Cuautitlán: Sierra de Manantlán, rocky summit of canyon 3 mi W of El Guízar, 9300 ft [near type locality?], flowers red, white, and green, 23 Nov 1968, *Boutin and Brandt 2550* (MICH); Mpio. Talpa de Allende: [Sierra Cacoma], 4 km due SE of Cuale along dirt road between El Tuito turnoff (5 km N of El Tuito and 32.2 mi by road E of Mex. Hwy 200 to Minas de Zimapán) and Talpa de Allende, rare, one plant, with *Begonia* and *Prochnyanthes mexicana* atop large rock outcrop in pine forest, 20° 22' N, 105° 04' W, 1920 m (altimeter), 18 Aug 1993, *Cochrane et al. 13136* (IBUG, TEX, WIS, ZEA).

The closest relatives of *Castilleja albobarbata* are within a group of species identified as *Castilleja* subg. *Castilleja* by Holmgren (1976) and sect. *Castilleja* by Nesom (1992). These species are characterized by (1) a racemose inflorescence, (2) colored calyces but usually green floral bracts, (3) calyces with a deeply cut (anterior) abaxial cleft and a shallow (posterior) adaxial one, and (4) corollas with the galea equalling or longer than the tube. A key to most of the Mexican taxa with this character constellation (including "white-bearded *Castilleja* Iltis & Nesom ined." = *C. albobarbata*), as well as detailed discussion and distribution maps for many of them, were provided in Nesom (1992).

Within sect. *Castilleja*, *C. albobarbata* is most similar to *C. integrifolia*. This pair is distinguished among its relatives by long pedicels (10–20 mm long), a dense beard on the upper side of the galea, and loose, racemose inflorescences terminated by a cluster of colored bracts. The new species differs from *C. integrifolia* in its short, ascending-appressed (antrorsely oriented) stem hairs, compared to the cauline vestiture in *C. integrifolia* of slightly longer (mostly 0.2–0.4 mm long), deflexed (retrorsely oriented) and closely appressed hairs. The orientation of stem hairs is consistent within both species, although it may be variable in related species (e.g., *Castilleja tenuiflora* Benth.). The galea of *C. albobarbata* produces a beard similar in density and trichome length to that of *C. integrifolia*, but the beard of the new species is bright white and a striking recognition feature.

Castilleja integrifolia is a wide-ranging and variable species, distributed from the paramos of the Andes Mountains in Colombia and Venezuela, broadly through the mountainous regions of most of Central America and southern Mexico, and on northward in the Sierra Madre Oriental of northeastern Mexico as far as northern Nuevo León and Coahuila. A map of its distribution in Mexico is shown in Nesom (1992, Map 2). The type specimen was collected in Colombia (*Mutis 82*, holotype: LINN, fiche!). Within its broad range, *C. integrifolia* is fairly common in appropriate habitat and mostly consistent in its basic morphological features. Regional variants exist, however, and these are incompletely

understood. One taxon, described as *C. chiapensis* Brandegee, is based on plants from the mountains of central Chiapas, having a densely villous vestiture of golden-yellow hairs. A second form, apparently endemic to central Oaxaca and described as *C. longibracteata* Mart. & Gal., is distinguished by its broadly obovate, fimbriate-tipped apical bracts. Type material for another variant, *C. integrifolia* var. *alpigena* L. Williams from Guatemala, appears to be referable to *C. pectinata* Mart. & Gal. The range of *C. integrifolia* in Mexico most closely approaches that of *C. albobarbata* in central Guerrero and Edo. México, across a gap of about 450 kilometers. The morphological distinction between the two taxa is consistent but not great – recognition of *C. albobarbata* at specific rank emphasizes its wide geographic disjunction from *C. integrifolia*.

This taxonomic disposition is further supported by the discovery of *Castilleja albobarbata* at the far northwestern end of Sierra Cacoma, an extensive, two-parted, southeast-to-northwest oriented mountain range of the Sierra Madre del Sur that begins where Sierra de Manantlán ends at Puerto Los Mazos. This locality is about 33 kilometers southeast of Puerto Vallarta and extends the range of *C. albobarbata* more than 110 kilometers northwest of the area of the type locality at Cerro Las Capillas. It also suggests that other stations of this rare species may yet be found at high elevations in between, in that vast area of rough topography still undercollected despite many years of concerted botanical activity.

The type locality of *Castilleja albobarbata* is most remarkable floristically and ecologically (Vázquez-G. et al. 1995). Perched atop an enormous, sheer and windswept, south-facing cliff, this crest of the central section of Sierra de Manantlán forms the very edge of the Sierra Madre del Sur and reaches its highest elevation (2800–2860 meters) at Cerro Las Capillas. Below, one can see on any clear evening, far beyond the parallel ridges of ever-lower hills, the shimmering Pacific Ocean at Manzanillo, some 60 kilometers to the south. Be it due to the near continual roaring winds from off the Pacific coast or the high altitude, be it the dry crumbly sandstone conglomerate or evidence of frequent fires, the vegetation on the crest is one of an open, burnt-over pine-oak parkland (*Pinus hartwegii* Lindl. sensu lato, see comments below), the scattered trees understoried by ericaceous shrubs and tussock grass ("sacaton"), giving the appearance of a Mexican subalpine "sacatonal." The low, evergreen ericaceous scrub consists of *Pernettia prostrata* (Cav.) DC., *Vaccinium confertum* Kunth, *Comarostaphylos discolor* (Hook.) Diggs subsp. *manantlanensis* Diggs, and the remarkable diminutive *Arbutus occidentalis* McVaugh & Rosatti, the latter two here at their type locality. Amongst our scattered and rare *Castilleja* are small patches of an as yet undescribed *Alchemilla* (*A. manantlanensis* Iltis, nom. prov.) seen nowhere else, and of the robust grass tussocks of a giant *Agrostis* known apparently only from this one site. With fully 8 dm tall culms from a woody, rhizome-like base, and with many, crowded, long leaves, *A. novogaliciana*

McVaugh is unusual in other ways as well. The author himself (McVaugh 1983:42) noted that "it is quite unlike any other Mexican species of *Agrostis* and indeed may be out of place in that genus."

On the gentler, cooler, moister, north-facing slopes, a few hundred meters below the crest and less susceptible to fire, is a mixed conifer-deciduous cloud forest of *Abies religiosa* (Kunth) Schltdl. & Cham., *Pinus hartwegii*, *Cupressus lindleyi* Endl., and *Quercus* spp. In its dense understory another *Castilleja* grows in abundance, the yellow and red-flowered *C. macvaughii* N. Holmgren, a shrub to 1.5 or even 2 meters tall, strictly endemic to the high elevation cloud forests a few kilometers east and west of Cerro Las Capillas. *Castilleja macvaughii* shares its cool habitat with the recently described, more widely distributed but always local *Symplocos sousae* F. Almeda and other endemics such as *Ageratina manantlanensis* B.L. Turner. Other, more widespread *Castilleja* species, at slightly lower elevations, include *C. nervata* Eastw. and *C. pterocaulon* N. Holmgren.

Finally, even the pines at Cerro las Capillas present a taxonomic problem. "*Pinus hartwegii*" sensu lato (as noted above) is listed in Vázquez et al. (1995:106) as *P. durangensis* Martínez, according to the botanists R. Cuevas-G. and S. Carvajal-H. In the discussion, however, the local pine expert J. Pérez de la Rosa suggested it to be *P. martinezii* E. Larsen, while W.B. Critchfield identified these collections as an aberration of *P. hartwegii*. Considering the great local endemism at this locality, it may yet prove to be an undescribed local variant, and thus Critchfield correct.

The concentration of so many endemics on the slopes or at the very top of Sierra de Manantlán, some 40 species in all (Vázquez et al. 1995; Hernandez 1995:72–81), suggests that this mountain, like so many others in Mexico, acted not only as a "survivium" (refugium) of a once more extensive montane and subalpine flora during periods of glacial cooling and of its remnants in the present post-glacial warming but, in addition, because of its isolation, as an "Inselberg," an island of autochthonous speciation, even if now only a few hectares in extent.

Similarly, the Sierra Cacoma station for *Castilleja albobarbata* lies in the center of a hotbed of endemism, which though only 30 to 40 kilometers southeast to southwest of the vacation mecca of Puerto Vallarta, has until recently remained relatively uncollected. Its exploration has been facilitated by the now already deteriorating east-west gravel road that starts out (from Mexican Highway 200) 5 kilometers north of El Tuito, goes east for 52 kilometers to the *Castilleja* locality near the now abandoned Minas de Zimapán, and continues beyond for 47 kilometers to Talpa de Allende. This "brecha" Tuito-Talpa opened up since the 1960's vast, previously inaccessible, forested lands, from the subtropical northern end of Sierra El Tuito (500–1880 m) south to the higher Sierra El Cuale (1000–2300 m) north of the road, and finally to the grand, rug-

ged, isolated end of the Sierra Cacoma (with several peaks above 2600 m and one to 2740 m!). Most of the collecting evidently occurred next to the road, as with the single plant of *Castilleja*. Yet, with its rocky pine forest habitat continuing up the mountain slopes for another 1800 meters to equal the altitude of the type collection, one can predict that it may yet reveal a much larger population. And the cloud forests that probably crown the peaks also offer potentially rich scientific rewards. In any case, all along the Minas de Zimapán road, these pine to oak woods have yielded a cornucopia of rarities and recently described local endemics: *Quercus tuitensis* L.M. González and *Q. cualensis* L.M. González (González-V. 2003a, b), *Pinus jaliscana* Perez de la Rosa, *Muhlenbergia cualensis* Herrera & P. Peterson, and various novelties in the genera *Aechmea*, *Agarista*, *Aristida*, *Triniochloa*, *Pedilanthus*, *Stevia*, and *Wedelia*.

What the flora of the highest peaks may yet yield is a tantalizing question. These are, after all, extensions of Sierra de Manantlán and equivalent in altitude to that of Cerro Las Capillas (2740 vs. 2860 meters). Here is a real botanical challenge to any young botanist, for soon it may be too late. Not only are lumbering and cattle grazing expanding up the mountains to supply an ever growing Mexican population, but global warming, world-wide, is a fact botanists need to consider.

What indeed will be the fate of many of these high-altitude microcenters of biodiversity, the "Inselbergs" of evolution, these biogeographic survivia, in consequence of global warming? Surely many of these endemics and rarities would soon be pushed off their high mountain perches by a warmer climate and displaced by pine forests or even cloud forests advancing from below. But as for the large number of rarities at Las Capillas, the type locality of *Castilleja albobarbata*, their survival for the time being is assured by protection in the Core Zone of the Sierra de Manantlán Biosphere Reserve (Guzmán-M. and Iltis 1991; Halffter 1987; Vázquez et al. 1995).

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IPOMOEA TACAMBARENSIS (CONVOLVULACEAE), ESPECIE NUEVA DEL ESTADO DE MICHOACÁN, MÉXICO

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RESUMEN

Se describe como especie nueva y se ilustra a *Ipomoea tacambarensis* (Convolvulaceae), que se encuentra en la depresión del Balsas en el estado de Michoacán, México. Esta planta, aunque de apariencia arbustiva, es una hierba perenne que alcanza hasta 2.2 m de alto. Es similar a *Ipomoea stans* Cav., pero se distingue por su mayor tamaño (de hasta 2.2 m de alto), las hojas más grandes (de hasta de 35 cm de largo) y las inflorescencias multifloras.

PALABRAS CLAVE: *Ipomoea*, Convolvulaceae, Michoacán, México

ABSTRACT

Ipomoea tacambarensis (Convolvulaceae) from the Balsas depression in the state of Michoacán, Mexico, is described and illustrated. Although shrub-like in appearance, it does not undergo considerable secondary growth, and is thus really a robust perennial herb to 2.2 m tall. It is very similar to *Ipomoea stans* Cav., but it is distinguished by its greater size (to 2.2 m tall vs. to 1 m tall), longer leaves (to 35 cm long vs. to 11 cm long) and many flowered inflorescence (vs. flowers solitary)

KEY WORDS: *Ipomoea*, Convolvulaceae, Michoacán, México

En la vertiente hacia la Cuenca del Balsas, en el Eje Neovolcánico y dentro del municipio de Tacámbaro, Michoacán, se encontró recientemente una planta herbácea vistosa y de porte erecto que pertenece al género *Ipomoea* (Convolvulaceae). Esta especie crece en laderas y cañadas con encinares, pinares o con bosque tropical caducifolio. Comúnmente forma parte de asociaciones vegetales secundarias en pequeñas áreas dedicadas al pastoreo de ganado bovino, o en lugares con cierto grado de alteración y relativamente cercanos a caminos y poblados.

Debido al tipo de hábito tan conspicuo y por encontrarse relativamente cerca de la carretera, es raro que esta planta haya pasado desapercibida por los botánicos. Sin embargo, la zona ha sido poco explorada desde el punto de vista biológico, lo que con seguridad ha limitado el conocimiento de varios hallazgos más.

Ipomoea tacambarensis E. Carranza, sp. nov. (**Figs. 1 y 2**). TIPO: MÉXICO. MICHOACÁN. Municipio de Tacámbaro: ± 1 km al N de Paso de Morelos, cañada perturbada, con transición de bosque tropical caducifolio y bosque de encino, 1550–1600 m, 3 Sep 2002, *E. Carranza* y *V. Steinmann* 6392 (HOLOTIPO: IEB; ISOTIPOS: para distribuirse en MEXU, ENCB, XAL, EBUM).

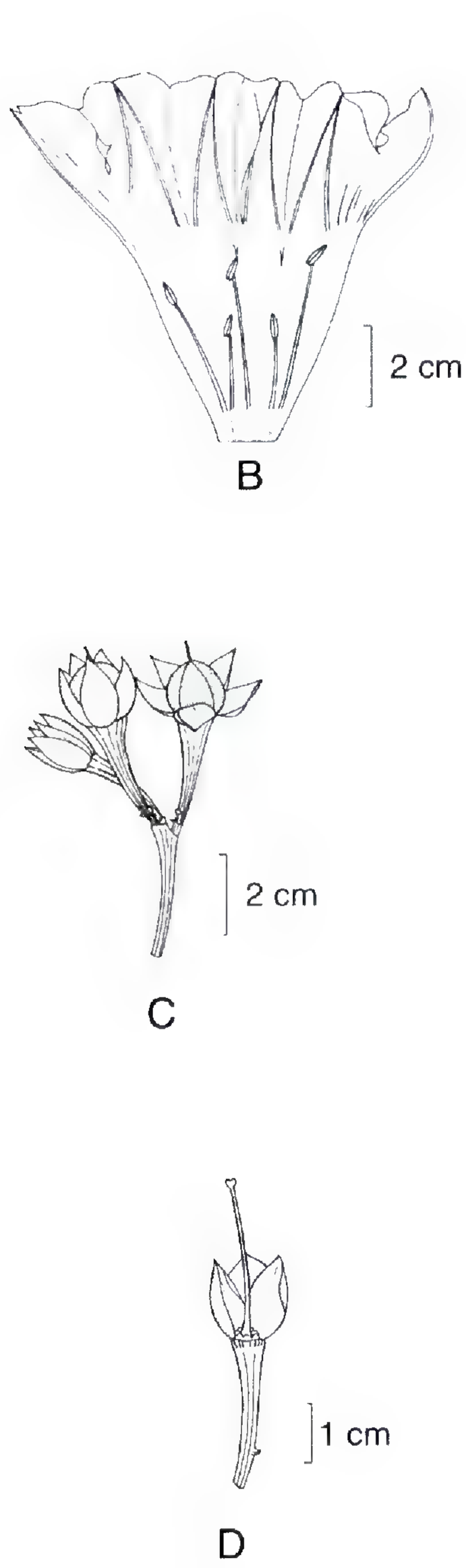


Fig. 1. ***Ipomoea tacambarensis*** **(basado en el ejemplar tipo:** ***E. Carranza*** **y** ***V. Steinmann 6392*** **(IEB)). A. aspecto de una rama. B. Flor abierta, mostrando la disposición de los estambres. C. Rama de infrutescencia. D. Estilo, con sépalos y pedúnculo. E. Semilla.**

Differt a *I. stans*, habitu ad 2.2 m alto; caule ad 3 cm diametro, ramificatione (30–)40 cm supra basin; foliis (10 -)16–30(–35) cm longis, (5–)12–24 cm latis, petiolis canaliculatis ad 4 cm longis, ad 5 mm diametro; inflorescentiis terminalibus vel axillaribus, multiflori; sepalis oblongo-ovatis, (13–)15–17 mm longis, 6–8 mm latis, aequalibus vel subaequalibus; stylo 3.5–4 cm longo.

Planta herbácea, erecta, de hasta 2.2 m de alto; tubérculo de 20 a 40 cm de largo y de 10 a 20 cm de diámetro, tallos principales 3 a 5, algo angulosos, huecos, de

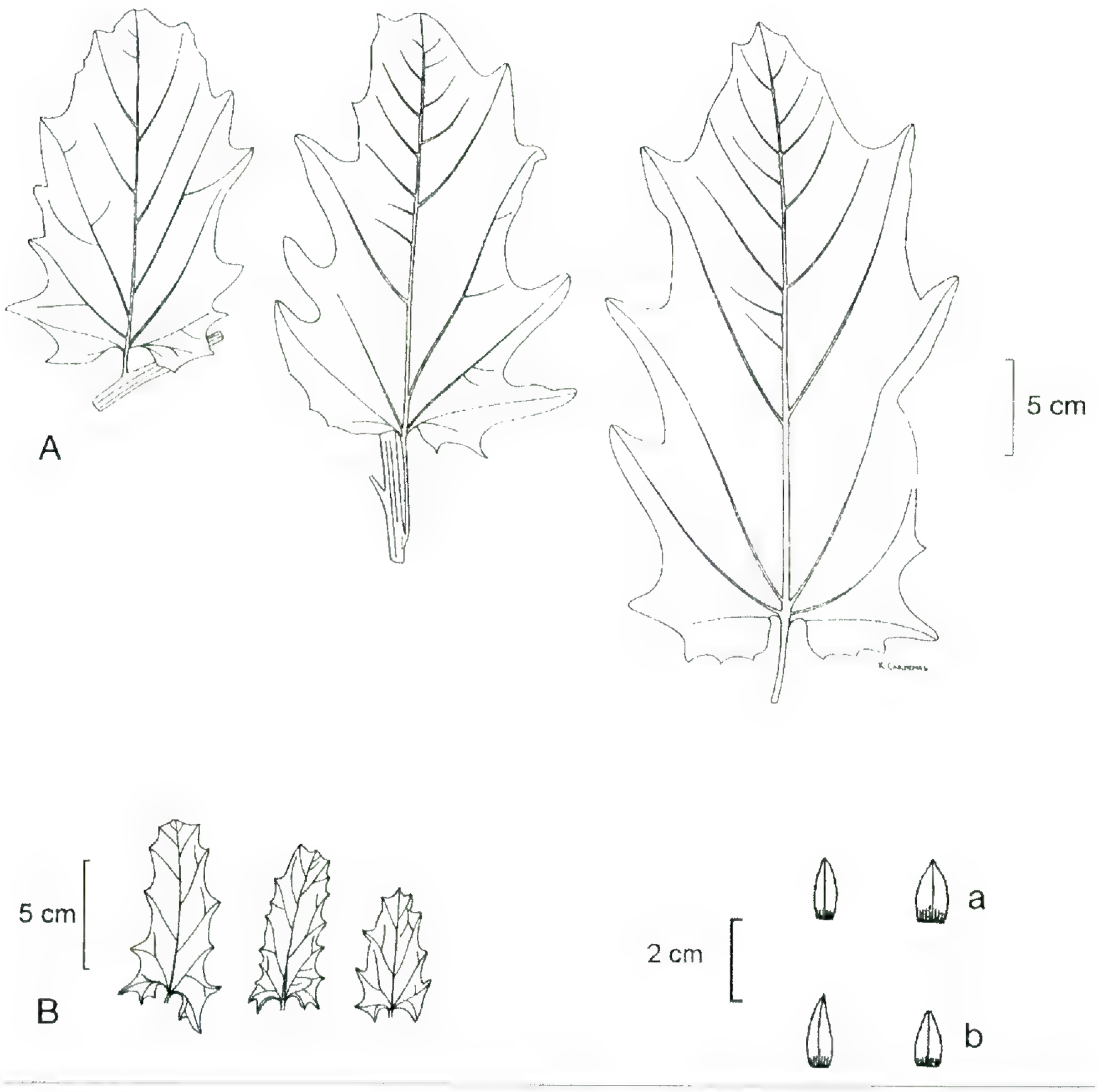


FIG. 2. Variación en tamaño de las hojas (A–B) y en la forma de los sépalos (a–b) de *Ipomoea tacambarensis* (A, a) e *Ipomoea stans* (B, b).

hasta 3 cm de grosor cerca de la base, ramificados a (30–)40 a 50 cm arriba de la base, ligeramente puberulentos; lámina foliar de contorno oblongo-ovado a anchamente elíptico, de (10–)16 a 30(–35) cm de largo, de (5–)12 a 24 cm de ancho, ápice redondeado a obtuso, base truncada a subcordada, margen profundo e irregularmente sublaciniado o dentado-lobulado, lóbulos agudos, mucronulados, venación conspicua en el envés, superficie puberulenta, a veces diminutamente pilosa en el envés, primordialmente sobre las nervaduras, pecíolo de (1.2–)2 a 4.5(–6) cm de largo, de 2 a 3(–5) mm de grueso, piloso, acanalado por el haz; inflorescencias axilares y terminales, en cimas dicasiales y monocasiales, flores (3–)5 a 15, pedúnculo primario de (6–)9 a 18(–20) cm de largo, de 2 a 3(–4) mm de grueso, glabrescente o piloso, pedúnculos secundarios de 7 a 15(–25) mm de largo, glabros, a veces pilosos, brácteas caedizas, linear-lanceoladas u oblongo-

ovadas, membranosas a escariosas, de 12 a 17 mm de largo, de hasta 6 mm de ancho, margen erósulo, o a veces irregularmente ciliado, pedicelos de (8–)12 a 30 mm de largo, glabros; sépalos escariosos, iguales o inconspicuamente subiguales, oblongo-ovados, de (13–)15 a 17 mm de largo, de 6 a 8 mm de ancho, los interiores ligeramente más anchos, glabros, rara vez los exteriores apenas pilósulos; corola infundibuliforme, de color rojo vino a azul-purpúreo, de 7 a 9 cm de largo, de 6 a 9 cm de diámetro en el limbo, el tubo más pálido que el limbo; estambres desiguales, de 2 a 4 cm de largo, filamentos blancos, pubescentes en la base, anteras de 5 a 7 mm de largo; estilo de 3.5 a 4 cm de largo, glabro, blanco, estigma globoso, algo bilobado; fruto una cápsula subglobosa a anchamente ovoide, bilocular, 4-valvada, de (8–)9 a 11 mm de largo, de (7–)8 a 9 mm de diámetro, glabra, de color pajizo a café oscuro; semillas 4, elipsoides, ± 3-anguladas, de color café, de (5–)6 a 8 mm de largo, de 4 a 6 mm de ancho, diminutamente pubescentes.

Ejemplares examinados: **MÉXICO. Michoacán. Municipio de Tacámbaro:** ± 8 km de Paso de Morelos, camino a Villa Madero, 3 Sep 2003, *E. Carranza* y *V. Steinnman* 6397 (IEB); al N de Paso de Morelos, 3 Ago 2003, *E. Carranza* y *P. Carrillo* 6390 (IEB).

Debido al hábito peculiar de esta planta, las hojas sublaciniadas o irregularmente dentado-lobuladas, fruto bilocular con semillas diminutamente pubescentes, la especie debe incluirse en *Ipomoea* serie *Tyrianthinae* (House) D. F. Austin, al lado de *I. ancisa*, *I. sescossiana* e *I. stans* (McDonald 2001).

El aspecto general de esta planta es similar al de *Ipomoea stans* Cav., principalmente en lo que respecta al porte erecto y la forma de las hojas. Sin embargo, *I. tacambarensis* tiene sépalos iguales o apenas subiguales, oblongo-ovados, los interiores un poco más anchos, hojas generalmente de 16 a 30 cm de largo y 12 a 24 cm de ancho y cimas multifloras. En contraste *I. stans* posee sépalos generalmente desiguales, los externos elípicos, los internos angostamente elípticos, hojas de 2.5 a 7 cm de largo, de 0.6 a 3 cm de ancho y flores solitarias. En el cuadro 1 se señalan con mayor detalle las diferencias entre estas especies.

Ecología.—El área donde prospera *I. tacambarensis* tiene suelos de tipo regosol y acrisol que se asientan sobre rocas de orígen ígneo, principalmente areniscas y conglomerados, entre 1500 y 1950 m de altitud. Los climas subhúmedos tanto cálidos como semicálidos predominan en el sitio tipo. Las condiciones ambientales de esta región se encuentran con diferentes grados de alteración, ocasionados básicamente por vías de comunicación, agricultura y pastoreo. Por lo menos en algunas zonas, estas plantas se ven favorecidas con dichas actividades.

Vegetación.—La vegetación donde crece esta especie varía desde la ecotonía de los bosques tropical caducifolio y de encino, en las partes con menor altitud, hasta el bosque de pino-encino en lo más alto. En la primer zona destacan especies de los géneros *Quercus*, *Bursera*, *Colubrina*, *Annona*, *Cordia* y *Ficus*. Además se encuentran plantas propias de ambientes perturbados, por ejemplo

CUADRO 1. Comparación morfológica y distribución geográfica de *Ipomoea stans* e *Ipomoea tacambarensis*.

	Ipomoea stans	***Ipomoea tacambarensis***
Hábito	Hierba erecta, hasta 1 m de alto	Hierba erecta, de más de 2 m de alto
Tallo	Hasta de 5 mm de grueso	Hasta de 30 mm de grueso
Hoja	Lámina de 2.5–7(11) cm de largo, de 0.6–3(–5) cm de ancho, subcoriácea; pecíolo de 2–4(–6) mm de largo, de 0.5–1 mm de grueso, cilíndrico	Lámina de (10–)16–30(–35) cm de largo, de (5–)12–24 cm de ancho, membranácea; pecíolo de (12–)20–45(–60) mm de largo, de 2–3(–5) mm de grueso, acanalado
Inflorescencia	Axilar; flores solitarias, rara vez en pares; pedúnculos de 0.8–5(–8.5) cm de largo, de 1–2 mm de grueso; pedicelos de 5–12 mm de largo	Terminal o axilar; cimas con (3–)5–15 flores; pedúnculos de (6–)9–18(–20) cm de largo, de 2–3(–4) mm de grueso; pedicelos de (8–)12–30 mm de largo
Sépalos	Desiguales, a veces subiguales, los externos elípticos, de 10–23 mm de largo, pubescentes, los internos angostamente elípticos	Iguales o apenas subiguales, oblongo-ovados, de (13–)15–17 mm de largo, de 6–8 mm de ancho, los interiors ligeramente más anchos, glabros, rara vez los exteriores pilósulos
Estilo	2.5–3 cm de largo	3.5–4 cm de largo
Distribución	Ampliamente distribuida en regiones semiáridas de México (Dgo., Zac., S. L. P., Gto., Qro., Hgo., Jal., Mich., D. F., Mor., Pue., Tlax., Ver., Oax.)	Restringida hasta donde se conoce, a una región semihúmeda de Michoacán, en la vertiente sur del Eje Neovolcánico hacia la Depresión del Balsas.

de los géneros *Verbesina* y *Acacia*, que manifiestan claramente la alteración de la vegetación. La zona de mayor altitud, donde también destacan elementos indicadores de disturbio, concentra como especies dominantes las que son propias de estas comunidades sobresaliendo *Pinus oocarpa* y *Quercus magnoliifolia*.

Al igual que otras especies de *Ipomoea*, a *I. tacambarensis* se le conoce con el nombre de "quiebraplatos." De acuerdo con los pobladores del lugar, tradicionalmente, los tallos y hojas son hervidos y utilizados a manera de baños, para contrarrestar los efectos de la picadura de animales venenosos (alacranes, víboras y otros); acompañados frecuentemente por la ingestión de un té preparado con el tubérculo de las mismas plantas.

El nombre de la planta alude al municipio de Tacámbaro en el estado de Michoacán, lugar donde crecen estas poblaciones.

Distribución.—Hasta ahora, sólo se conoce de la localidad tipo y en otro sitio relativamente cerca de ésta. Se sabe además, por información de los habitantes de la zona, que se encuentra en varias de las numerosas cañadas y

laderas similares, aledañas al área de colecta. Es probable que se trate de una planta endémica a esta región.

Fenología.—Florece de agosto a septiembre y los frutos maduran algunos meses después, encontrándose sus restos aún al principio de la floración del siguiente año.

AGRADECIMIENTOS

Deseo expresar mi agradecimiento a J. Rzedowski por la revisión crítica del manuscrito, en especial la diagnosis en latín, lo mismo que a A. McDonald y V. Steinmann. Igualmente agradezco a este último y a P. Carrillo por su compañía durante las exploraciones de campo, así como a R. Cárdenas por la elaboración del dibujo. Finalmente, este trabajo ha sido posible gracias al apoyo económico brindado por el Instituto de Ecología, A. C. (cuenta 902-07).

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PORTULACA MATTHEWSII (PORTULACACEAE), A NEW SPECIES FROM THE "SIERRA GORDA" BIOSPHERE RESERVE, QUERÉTARO, MEXICO[1]

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ABSTRACT

Portulaca matthewsii is proposed and described as a new species. It belongs to subg. *Portulaca* sect. *Catoclasis* subsect. *Conocarpae*, and has been collected in the northern part of the "Sierra Gorda" Biosphere Reserve, in the Mexican state of Querétaro. The new taxon primarily differs from the known Mexican species of this subsection by the fibrous roots and by the stellate-tuberculate surface of the seed.

KEY WORDS: Mexico, *Portulaca*, Portulacaceae, Querétaro, "Sierra Gorda" Biosphere Reserve

RESUMEN

Se propone y describe a *Portulaca matthewsii* como especie nueva para la ciencia. Este taxon se ubica en el subgénero *Portulaca*, sección *Catoclasis*, subsección *Conocarpae*, y ha sido colectada en la porción norte de la Reserva de la Biosfera "Sierra Gorda", en el estado mexicano de Querétaro. La entidad nueva se diferencia de las especies de la subsección conocidas para México por la presencia de raíces fibrosas, así como por la superficie de la semilla que es estelulado-tuberculada.

PALABRAS CLAVE: México, *Portulaca*, Portulacaceae, Querétaro, Reserva de la Biosfera "Sierra Gorda"

During preparation of the treatment of Portulacaceae for the *Flora del Bajío y de Regiones Adyacentes*, Mexico, some specimens of the genus *Portulaca* collected in the "Sierra Gorda" Biosphere Reserve in the state of Querétaro were detected to have a campanulate capsule operculum. This feature, in addition to others, places the specimens in subsect. *Conocarpae* D. Legrand (subg. *Portulaca* sect. *Catoclasis* D. Legrand (Legrand 1962)). (Even though Legrand's approach is focused mainly in the American species of *Portulaca* and does not consider the variation presented by the genus in a global scale, his systematic arrangement has been very useful in characterizing the New World Portulacas; nevertheless, a modern revision for the whole genus is considered necessary). Beyond this placement, they could not be determined to species, so here they are proposed as:

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Portulaca matthewsii G. Ocampo, sp. nov. (**Fig. 1**). TYPE: MEXICO. QUERÉTARO. Municipality of Landa: Puerto del Gato, 3 km al W de Acatitlán de Zaragoza, bosque de encino, ladera de cerro, 1450 m, 29 Jul 1988, *E. González 44* (HOLOTYPE: IEB; ISOTYPES: MEXU, QMEX, XAL).

Herba perennis crassiuscula; radix fibrosa; caules usque ad 15 cm longi, prostrati vel decumbentes; folia alterna, subteretia, lanceolata, oblongo-lanceolata, oblanceolata vel elliptica, 3–10 mm longa, 0.6–2.5(–3) mm lata, apice acuta vel subacuta, aliquando obtusa; sepala deltata, rubra, (3–)3.5–4.5(–5) mm longa, 2.5–4(–4.5) mm lata; petala magentea vel purpurea, obovata vel oblongo-obovata, (4–)5.5–8 mm longa, (2.5–)3–4 mm lata; stamina (13–)16–28; stylus (3–)4–5 mm longus, lobis stigmatosis 3(–4); capsula (2.5–)3–4(–4.5) mm longa, operculum campanulatum; semina reniformia, nigra vel coracina, (0.5–)0.6(–0.7) mm longa, testa stellato-tuberculata.

Fleshy perennial herb with fibrous roots; stems several from the base, usually suffrutescent in their lower portion, prostrate to decumbent, 4–15 cm long, sparsely branched above, glabrous; axilar hairs scarce, 3–5(–6) mm long; leaves alternate; petiole 1–1.5(–2) mm long; lamina lanceolate, oblong-lanceolate or oblanceolate to elliptic, 3–10 mm long, 0.6–2.5(–3) mm wide, subterete in cross section, apex acute to subacute, rarely obtuse; flowers clustered in a head in groups of 4–7, subtended by an involucre of 6–8(–10) leaves, surrounded by hairs 3–4.5(–5) mm long; sepals reddish, deltate, clasping, (3–)3.5–4.5(–5) mm long, 2.5–4(–4.5) mm wide, apex acute, margin scarious; petals magenta to purple, obovate to oblong-obovate, (4–)5.5–8 mm long, (2.5–)3–4 mm wide, apex obtuse to emarginate, usually apiculate; stamens (13–)16–28; filaments connate at the base and forming a tube 0.6–0.8 mm long, the filaments (2–)2.5–3.5 mm long; anthers 0.4–0.6(–0.7) mm long; style (3–)4–5 mm long, stigma lobes 3(–4); fruiting pedicel 0.5–0.7 mm long; capsule (2.5–)3–4(–4.5) mm long, 2–3 mm in diameter, circumscissile in the lower third; operculum campanulate; seeds (0.5–)0.6(–0.7) mm long, reniform, black to bluish-black, testa with tubercles stellate at the base.

Additional specimens examined: **MEXICO. Querétaro. Municipality of Jalpan:** 3–4 km al N de La Parada, 20 Jun 1991, *B. Servín 1146* (IEB); ± 2 km de La Tinaja, camino a El Lindero, 15 Aug 1989, *E. Carranza 1976* (IEB). **Municipality of Landa:** ± 0.5 km al SW de El Lobo, 15 Aug 2002, *G. Ocampo & E. Pérez 1202* (IEB); 1 km al SW de El Lobo, 1 Aug 1987, *J. Rzedowski 44051* (ENCB, IEB); ± 4 km al E de La Vuelta por la carretera a Xilitla, 25 Sep 2002, *S. Zamudio & V. Steinmann 12125* (IEB); along MEX 120, 5 km (by road) E of the turnoff to La Vuelta, 25 Sep 2002, *V. W. Steinmann & S. Zamudio 2832* (IEB); 12 km al SW de El Lobo, sobre la carretera a Landa, 1 Aug 1987, *J. Rzedowski 43969* (ENCB, IEB).

Portulaca matthewsii is found in the municipalities of Jalpan and Landa, Querétaro, in the northern portion of the "Sierra Gorda" Biosphere Reserve. This region is part of the Sierra Madre Oriental mountains system, and it is highly probable that the new entity also occurs in closely adjacent areas of the state of San Luis Potosí. The new species grows in rocky open places, on limestone substrate, in pine-oak forest, oak forest, oak-juniper forest and submontane scrub, as well as in grassland, from elevations of 1300 to 1600 m (4300–5200 ft). It has been collected with flowers and fruits from June to September. The local abun-

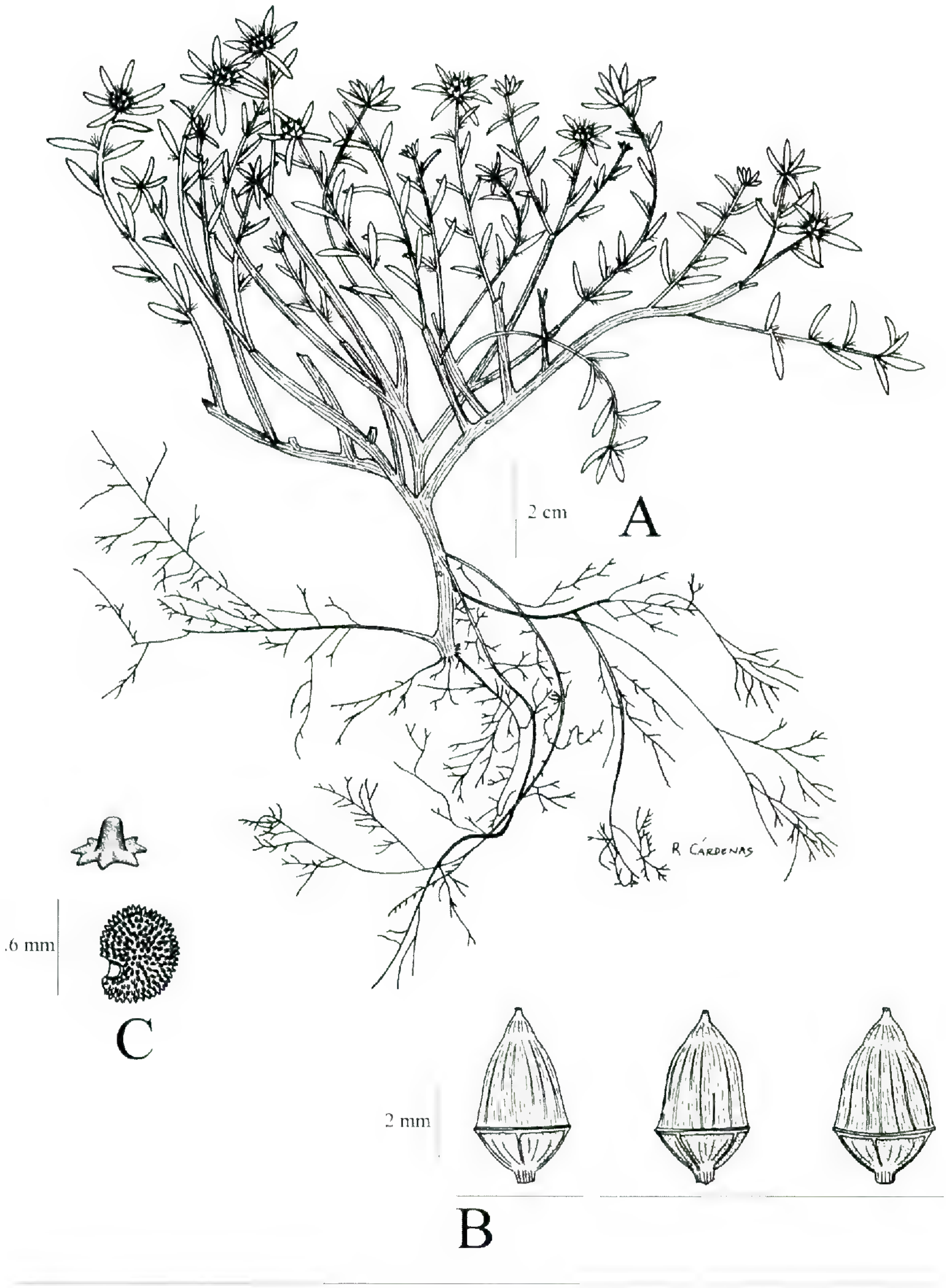


FIG. 1. *Portulaca matthewsii*. A. Habit. B. Capsules. C. Seed, showing a close-up to a tubercle.

TABLE 1. Comparison of *Portulaca matthewsii* with other species of subsection *Conocarpae* found in Mexico.

		P. matthewsii	***P. mexicana***	***P. rzedowskiana***
Root		Fibrous	Fascicled, thickened, not suberous	Thickened, suberous
Stem		4–15 cm long	to 10 cm long	4–26 cm long
Leaves	Shape	Subterete, lanceolate, oblong-lanceolate or oblanceolate to elliptic	Terete, linear to sublinear	Flat to subterete, lanceolate, some times oblong-lanceolate to oblanceolate
	Size	3–10 mm long 0.6–2.5(–3) mm wide	4–10 mm long 1.5–2 mm wide	4–20 mm long 1–3(–4.5) mm wide
	Apex	Acute to subacute	Subacute to obtuse	Acute
Sepals		(3–)3.5–4.5(–5) mm long 2.5–4(–4.5) mm wide	4.5–5 mm long 1.5–2 mm wide	(3–)4.5–6.5 mm long 4–5.5(–6.5) mm wide
Petals	Color	Magenta to purple	Yellow	Pink to purple
	Size	(4–)5.5–8 mm long (–2.5)3–4 mm wide	4.5–6 mm long	(5.5–)6.5–11 mm long (3–)3.5–6(-7) mm wide
No. of stamens		(13–)16–28	14–21	22—44
Style	Size	(3–)4–5 mm long	1.5–3 mm long	4.5–6(–8) mm long
	No. of stigma lobes	3(–4)	4–5	(3–)4–5(–6)
Capsule		(2.5–)3–4(–4.5) mm long	3–4.5 mm long	3.5–6 mm long
Seeds	Color	Black to bluish-black	Black	Bluish-black
	Size	(0.5–)0.6(-0.7) mm long	0.5 mm long	0.6–0.7(–0.8) mm long
	Surface	Stellate-tuberculate	Diminutively tuberculate	Stellate
Habitat	Vegetation	Pine-oak forest, oak forest, oak-juniper forest, submontane, grassland	Desert scrub, grassland	Disturbed subtropical scrub, grassland
	Altitude	1300–1600 m (4300–5200 ft)	1800–2550 m (5900–8400 ft)	1600–2500 m (5200–8200 ft)
Distribution		Querétaro; possibly also San Luis Potosí	Central Mexico, (Colombia?, *P. solferina* Poelln.)	Michoacán, Estado de México, Morelos

dance of this species is reported from scarce to abundant, so it can be considered that is not in danger of extinction at present.

The new taxon belongs to subg. *Portulaca* sect. *Catoclasis* D. Legrand subsect. *Conocarpae* D. Legrand. This subsection is characterized by the size of the capsules (2.5 to 5(–6) mm long), dehiscing in its lower third portion, by its campanulate to tubular-campanulate (rarely hemispherical) operculum, as well as by its linear to oblong-elliptic leaves that are sometimes more or less compressed (D. Legrand 1962). Only two species from this subsection were previously reported to occur in Mexico: *P. mexicana* P. Wilson (Torreya 28:29. 1928) and *P. rzedowskiana* Ocampo (Sida 20:487. 2002). *Portulaca matthewsii* primarily differs from these by having fibrous roots and by the stellate-tuberculate testa of the seed. In addition, *P. mexicana* is distinguished from *P. matthewsii* by its yellow petals, and terete, linear to sublinear leaves. *Portulaca rzedowskiana* differs from the new entity by its larger dimensions of sepals, petals and capsules; and higher number of anthers and stigma lobes (Table 1).

Etymology.—The new species is named in honor of James F. Matthews, whose research on *Portulaca* represents a very important contribution to the knowledge of the genus in North America.

ACKNOWLEDGMENTS

I am grateful to Victor W. Steinmann, James Henrickson and John McNeill for helpful comments and corrections to the manuscript; and to Rogelio Cárdenas for the illustration of the new species.

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BOOK REVIEW

ELIZABETH A. (BERNDT) GEORGE. Watercolour paintings and illustrations by MARGARET PIERONI. 2002. **Verticordia: The Turner of Hearts.** (ISBN 1 876268 46 8, hbk.). University of Australia Press, Crawley, Western Australia 6009, www.uwapress.uwa.edu:au. (Orders: International Specialized Book Services, 5824 NE Hassalo St., Portland, OR 97213-3644, U.S.A. 503-280-8832 fax; www.isbs.com; info@isbs.com). $84.95, 422 pp., 28 color photos, 39 figs., 44 maps, 149 color plates, 6 tables, glossary, 8 1/2" × 11 1/2".

This magnum opus is a product of ten years of collecting, mounting, and photographing 1400 specimens of *Verticordia* (Myrtaceae) by the author and more than 250 volunteer helpers. Furthermore, the artist, Margaret Pieroni, worked over a period of eighteen years to paint the 147 species, subspecies, and varieties pictured in the book. She wanted to paint each plant in full flower from the actual specimen and not only had to depend on chance to achieve that, but over the years the number of known species kept increasing. The result of this collaboration is a very comprehensive study of a genus unique to Western Australia and the Northern Territories. It is a splendid introduction for anyone who wants to become familiar with this less well known genus and a valuable resource for the specialist.

The enormous amount of material about *Verticordia* has been well-organized by the author. Her introduction discusses every aspect of the genus: from its ancient origins to its cultivation today, from chromosome studies to its use in art and craft.

The following section contains tables of species arranged by chronological order of naming, by chromosome number, by flowering characteristics, and by habit. There is a good glossary, and a key to infrageneric taxa and species. A line drawing illustrates each subgenus and section.

The main part of the book is devoted to the illustrations and treatments of the species. Each of the 102 color plates is faced by a page of text and a map showing where the species may be found. The watercolors are in the genre of botanical painting where the aim is to convey information, and these paintings show close scrutiny of the specimen by the artist. A line drawing of the reproductive system of the plant is included on each plate. This is somewhat unfortunate especially when the painting is on a colored background. The decision to show the flowering twig precluded the possibility of portraying the habit of this shrubby plant. The spectacular masses of color can be seen in the photographs.

The author's aim is to share information about *Verticordia*. It is a worthwhile project as the genus may not be well-represented in herbaria outside of Australia. The BRIT Herbarium of about 1,000,000 specimens has only ten examples of this interesting genus.—*Ruth Ginsburg, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

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A NEW SPECIES OF *CHAPTALIA* (ASTERACEAE: MUTISEAE) FROM MEXICO AND REDISCOVERY OF *CHAPTALIA MEXICANA*

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ABSTRACT

A new species, **Chaptalia hidalgoensis** L. Cabrera & Nesom, is described and illustrated. It is known only from the type collection made in Mun. Zimapan, Hidalgo. The occurrence of *Chaptalia mexicana* Burkart is documented here, with description and illustration, apparently for the first time since the type was collected by Ehrenberg in 1840. The recent collection was made in Mun. Pinal de Amoles, Querétaro. Both of these Mexican species appear to be members of sect. *Chaptalia*.

RESUMEN

Una nueva especie, **Chaptalia hidalgoensis** L. Cabrera & Nesom, se describe e ilustra; ésta se le conoce únicamente de la colección tipo del Mun. Zimapan, Hidalgo. También documentamos la existencia de *Chaptalia mexicana* Burkart, proporcionando una descripción completa e ilustración; aparentemente esta especie no se había vuelto a colectar desde la colecta tipo de Ehrenberg en 1840. Esta colección reciente es del Mun. Pinal de Amoles, Querétaro. Ambas especies mexicanas parecen ser miembros de la sección *Chaptalia*.

Research by the first author toward a treatment of Mutisieae of the Bajío region of México has brought to light two interesting discoveries in *Chaptalia* Vent. A new species is described, and the first known collection of *C. mexicana* Burkart since its initial discovery in 1840 is documented.

Chaptalia hidalgoensis L. Cabrera & Nesom, sp. nov. (**Fig. 1**). TYPE: MEXICO. HIDALGO: Mun. Zimapan. Verdosas, bosque de pino, encino y *Juniperus*, 1750 m, 20 Nov 1991, *V.M. Huerta 1352* (HOLOTYPE: IEB!).

Chaptaliae lyratifoliae et alio sect. *Chaptaliae* similis flosculis centralibus fungenter staminatis—differt ab omnibus coniunctione rhizomatum, scaporum bracteatorum, foliorum coriaceorum lyratorum, flosculorum pistillatorum interiorum numerosorum, et acheniorum non rostratorum; differt a *C. lyratifoliae* scapis bracteatis, phyllariis marginibus glandulosis, flosculis pistillatis exterioribus paucioribus ac flosculis pistillatis interioribus multo paucioribus, et flosculis bisexualibus corollis brevioribus.

Plants perennial, fibrous-rooted, rhizomatous. **Leaves** coriaceous, 3–5 cm long, blades 1.5–3.6 cm long, 1.1–2.1 cm wide, elliptic-oblong to ovate, lyrate, with an ovate to ovate-cordate terminal portion and 1(–2) pairs of basal lobes, margins

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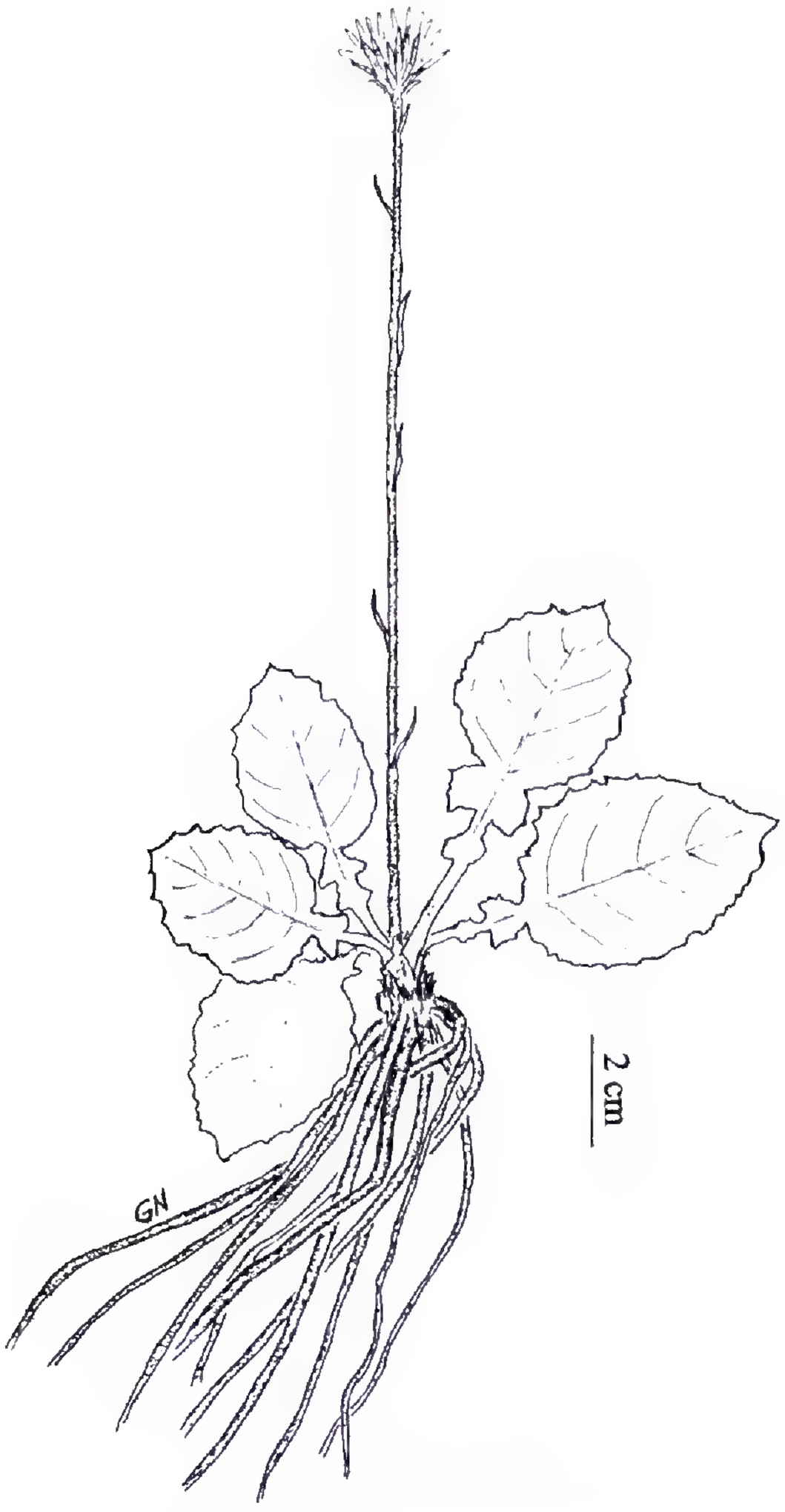


Fig. 1. Habit of *Chaptalia hidalgoensis*, from the type.

crenate to denticulate, revolute, apex acute to obtuse and mucronate, the base cordate, lower surface white-gray tomentose, upper surface villous-arachnoid, glabrescent. **Scapes** 1–3 per plant, 8–12 cm tall, villous to almost glabrous, tomentulose close to the head, 6–9-bracteate, bracts linear-lanceolate, 3–5.2 mm long, also with 3 bract-like phyllaries close to or subtending the involucre (i.e., bracts transitional to phyllaries). **Heads** solitary, 1.1–1.7 cm tall, 1.4–1.8 cm wide; involucres turbinate, 0.8–0.9 cm tall, phyllaries 3-seriate, green, herbaceous, all acute, scarious at the margins, with the distal area usually dark-red, the dorsal surface somewhat arachnoid, soon glabrous, the outermost linear-lanceolate, ca. 2.8 mm long, 0.5–0.7 mm wide, margins sparsely glandular, the central lanceolate, 4–5.2 mm long, 0.8–1 mm wide, margins sparsely glandular, the innermost ca. 8 mm long, ca. 1 mm wide, margins glabrous. **Florets** trimorphic—*outer*

pistillate and ligulate, *middle* pistillate with reduced ligules, *inner* bisexual and tubular-bilabiate: **outer florets** 15–21 in 1 series, ligules white-cream in color, sometimes somewhat purple with age, with an abaxial purplish midstripe at maturity, 10 mm long, ca. 1 mm wide, the tube 2.8 mm long, the inner lips 1–3, filamentous, 1–1.2 mm long, the style 5.2 mm long, including the branches 0.2–0.3 mm long; **middle florets** ca. 7, ligules ca. 6 mm long, ca. 0.4 mm wide, the tube almost as long as the ligule, inner lip absent; style 6 mm long including the ca. 0.5 mm long branches; **inner florets** ca. 22, corollas bilabiate, creamy in color, 7 mm long, including the 5 mm long tube and the recurved lobes 2–3 mm long; stamens 4.5 mm long, appendage 1.5 mm long, tails ca. 1.2 mm long, thecae ca. 1.8 mm long. **Achenes**: (outer pistillate florets) immature but apparently fertile, ca. 2 mm long, papillose over whole surface, cylindric; pappus biseriate, ca. 5 mm long; (inner pistillate florets) fertile, ca. 2.5 mm long, fusiform, apparently not beaked, papillate; pappus uniseriate, 5–5.5 mm long; (bisexual florets) sterile, ca. 2 mm long, cylindric, with few hirsute hairs; pappus biseriate, 6.2 mm long. Known only from the type collection, where it was reported as scarce.

Chaptalia hidalgoensis (as well as *C. mexicana*, below) appears to be a member of sect. *Chaptalia*, as outlined by Nesom (1995)—recognized by the production of functionally staminate (pseudo-bisexual) central florets, ligules of the outer pistillate florets with a purplish, abaxial midstripe at maturity, and heads nodding in bud. Previously, only one of the six species of sect. *Chaptalia* was known to produce consistently bracteate scapes—both of the species discussed in the present manuscript have bracteate scapes. The behaviour of the heads in the two species treated here in detail is inferred from their putative relatives.

Within sect. *Chaptalia*, *C. hidalgoensis* mostly closely resembles *C. lyratifolia* Burkart in its coriaceous and lyrate leaves. One of the plants of the Huerta collection shows production of short rhizomes (the other plant collected without any below-ground parts) and because of the similarities of *Chaptalia hidalgoensis* to *C. lyratifolia*, which characteristically is colonial through production of creeping or stoloniform rhizomes, it seems probable that *C. hidalgoensis* also has a colonial habit. A summary of distinctive contrasts of the new species with *C. lyratifolia* is given in the key below (following comments on *C. mexicana*). The latter species is distributed from central Nuevo León and adjacent Coahuila and Tamaulipas into central San Luis Potosí.

Rediscovery of *Chaptalia mexicana*

Chaptalia mexicana Burkart was described and illustrated (Burkart 1944) from a single collection, cited below. A more recent collection from Querétaro is the second known and documents its continued existence, although the species, which was inadvertently omitted in Nesom's review of the North American and Central American species (1995), apparently is rare elsewhere.

Chaptalia mexicana Burkart, Darwiniana 6:543. 1944 (**Fig. 2**). TYPE: MEXICO. [No other locality data], 1840, *Ehrenberg 1042* (HOLOTYPE: B, fide Burkart 1944).

Recent collection: **MEXICO. Querétaro:** Mun. Pinal de Amoles, más o menos 2 km al N de Puerto de Tejamanil, bosque de encino, ladera de cerro, cañada, 2400 m, 27 Mar 1989, *E. Carranza 1571* (IEB). The sheet includes three plants.

Plants perennial, fibrous-rooted, producing rhizomes at least to 1.4 cm long. **Leaves** 3.5–9.2 cm long, dissected into 5–7 pairs of somewhat retrorse lobules, these increasing in size distally, the terminal lobe 1.6–3 cm long, 1.1–2.1 cm wide, ovate to ovate lanceolate, with the margins retrorse-crenate, the lower surface gray-white tomentose, the upper surface dark-green with red-tinges, lightly villous to glabrous with age, the midvein very prominent, villous-tomentose, dark red, becoming white-tomentose distally; petioles 0.8–1.5 cm long, winged, white-villous. **Scapes** 1–2 per plant, 4–10.5 cm tall, white-tomentose, (2–)4–6[8–10]-bracteate, bracts linear-lanceolate to trullate, 4–5.5 mm long, 0.5–0.8 mm wide. **Heads** solitary, 1.4–2 cm tall, 1.1–1.8 cm wide; involucres 0.9–1.3 cm tall, turbinate-campanulate, phyllaries 3-seriate, acuminate, the outermost red-dark, somewhat herbaceous, linear-lanceolate, 4–5.5 mm long, 0.5–0.8 mm wide, scarious at the margins, arachnoid on the dorsal surface, the central red-dark to green, somewhat scarious, lanceolate, 10–11 mm long, ca. 1 mm wide, scarious on the margins, somewhat villous on the dorsal surface, the innermost more or less scarious to somewhat greenish, lanceolate, 12–13 mm long, ca. 1 mm wide, glabrous dorsally. **Florets** trimorphic—*outer* pistillate and ligulate, *middle* pistillate with reduced ligules, *inner* bisexual and tubular-bilabiate: **outer florets** 15–17 in 1 series, ligules white-cream, with an abaxial purple midstripe when mature, [7]12–14 mm long, 1.1–1.8 mm wide, the tube 3–3.5 mm long tube, the inner 2 lips ca. [1]1.5–2.1 mm long, filamentous; style ca. 5.8–8 mm long, including the [0.6]0.2 mm long branches; **middle florets** 7 mm long, 0.7 mm wide, the tube 2.5–3 mm long, inner lip ca. 0.5 mm long; style 8 mm long including the ca. 0.2 mm long branches; pappus 5 mm long; **inner florets** 17–20, 8.5 mm long, the tube ca. 4.5 mm long, the semi-erect to recurved lobes ca. 4 mm long; stamens ca. 6 mm long, the filaments 2 mm long, the tails ca. 1.2 mm long, the appendage ca. 1.5 mm long, thecae ca. 2.5 mm long, fertile. **Achenes**: (outer pistillate florets) fertile, ca. 3–4 mm long, fusiform, papillose; pappus biseriate, 4–7 mm long; (inner pistillate florets) fertile, 3.5 mm long, fusiform, apparently not beaked, sparsely papillose, pappus 5 mm long; (bisexual florets) sterile, ca. 3 mm long, narrowly cylindric, glabrous; pappus uniseriate, 8 mm long. Square brackets [ ] enclose data from Burkart description.

The scape of the Ehrenberg type of *Chaptalia mexicana* (as illustrated by Burkart) appears to have 8–10 bracts, vs. (2–)4–6 in the recent Carranza collection, and several other measurements in Burkart's description vary from the recent collection, but the combination of bracteate scapes and the highly dis-

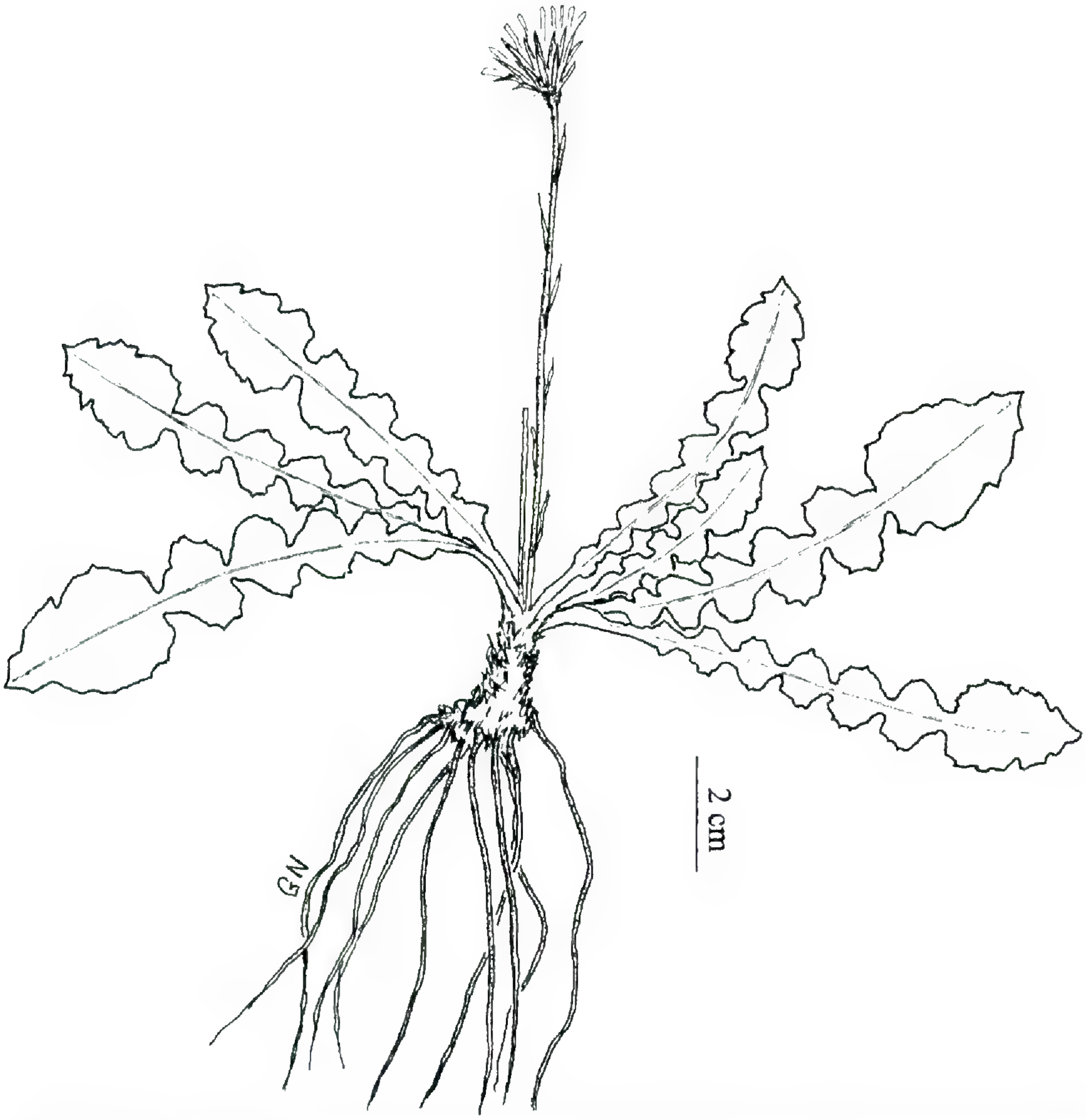


FIG. 2. Habit of *Chaptalia mexicana*, from *Carranza 1571*.

sected leaves is so remarkable that it is difficult to conclude that these are not the same species.

To arrive at an identification of *Chaptalia mexicana* using Burkart's key (1944, p. 524), which places the species in sect. *Lieberkuhna*, one must follow the choice "Flores centrales hermafroditas" (vs. "Flores centrales del capítulo masculinas, con ovario atrofiado."). His protologue for the species described "flores centrales hermafroditas" (p. 544), but he explicitly noted further down in the description that he did *not* see the achenes (probably meaning mature achenes, since his illustration included essentially similar ovaries at the base of each of the three kinds of corollas). It seems clear that Burkart would have placed this species in his sect. *Euchaptalia* if he had observed central florets

with sterile achenes. Our observation is that ovaries of the central (pseudo-bisexual) florets of *Carranza 1571* are glabrous and remain narrowly cylindric, while those of the pistillate florets are papillose and swell with the production of embryos.

Ehrenberg's type collection apparently did not include rhizomes, and the rhizomes on the Carranza collection are short, but because of the similarities of *C. mexicana* to *C. lyratifolia* and *C. estribensis* (leaves coriaceous and lyrate to cordate; style branches U-shaped, see comments below), it seems likely that the former also is colonial through production of creeping or stoloniform rhizomes.

KEY TO THE SPECIES OF SECT. *CHAPTALIA*

1. Leaves basally attenuate, not lyratiform; plants without rhizomes, occurring individually.
   2. Scapes bracteate; pistillate florets in 1 series, prominently ligulate; fertile achenes with a short, slightly constricted neck. _____ **Chaptalia pringlei** Greene
   2. Scapes ebracteate; pistillate florets in 2 series, those of the outer series ligulate, those of the inner series with ligules absent or greatly reduced; fertile achenes with a nearly filiform beak.
      3. Leaves oblanceolate-spatulate, with a narrowly attenuate petiolar region; fertile achenes 6–9 mm long, including the slender neck 1/2–1/2 as long as the achene, sparsely papillate over the whole surface. _____ **Chaptalia madrensis** Nesom
      3. Leaves elliptic to elliptic-obovate, without a petiolar region; fertile achenes 3.5–5.2 mm long, including the slender neck 1/4–1/5 as long as the achene, glabrous except for the sparsely papillate neck region. _____ **Chaptalia tomentosa** Vent.
1. Leaves basally cordate and/or distinctly lyratiform; plants rhizomatous and colonial.
   4. Leaf blades thin-herbaceous, sometimes reddish. _____ **Chaptalia hintonii** Bullock
   4. Leaf blades thick-coriaceous, not reddish.
      5. Leaf blades cordate, without lyrate extensions, with orange-tawny vestiture on the abaxial surface. _____ **Chaptalia estribensis** Nesom
      5. Leaf blades cordate to truncate at base, distinctly lyrate, with white vestiture on the abaxial surface.
         6. Leaves dissected into 5–7 pairs of somewhat retrorse, roughly equal-sized lobules; scapes bracteate. _____ **Chaptalia mexicana** Burkart
         6. Leaves lyratiform, usually with one terminal primary lobe and 0–2(–4) smaller basal lobules; scapes bracteate or ebracteate.
            7. Scapes bracteate; phyllary margins sparsely glandular; outer pistillate florets 15–21, inner lip 1–1.2 mm long; middle florets (pistillate) ca. 7, fewer than outer; corollas of bisexual florets 7 mm long. _____ **Chaptalia hidalgoensis** Cabrera & Nesom
            7. Scapes ebracteate; phyllary margins eglandular; outer pistillate florets 24–38, inner lip absent or less than 0.5 mm long; middle florets (pistillate) often more than 90, usually 3× more numerous than outer; corollas of bisexual florets 9–12 mm long. _____ **Chaptalia lyratifolia** Burkart

Generic placement

Katinas (1998) transferred *Chaptalia hintonii* to the genus *Gerbera* Gmel., which otherwise (except for one South American species) has been recognized

only from Africa and Asia. Her rationale for the transfer emphasized the production of staminodes on the outer pistillate florets of *C. hintonii*, a feature characteristic of *Gerbera* but usually not of *Chaptalia*, and the "U-shaped" style branches of *C. hintonii*. We acknowledge that generic limits among taxa of the *Gerbera* complex are somewhat ambiguously drawn and may yet require taxonomic adjustments, but it does seem clear that *C. hintonii* is a member of the group of five species within sect. *Chaptalia* (as recognized here) characterized by production of stolons and cordate to lyratiform leaves (*C. estribensis*, *C. hidalgoensis*, *C. hintonii*, *C. lyratifolia*, and *C. mexicana*). All species of this group also produce the U-shaped style branches. Style branches are more slender and "V-shaped" in the three species of sect. *Chaptalia* with basally attenuate leaves and without stolons (*C. madrensis*, *C. pringlei*, and the type of the genus, *C. tomentosa*)—the style branch morphology is more like that of species of sect. *Leria* (DC.) Burkart, which includes *C. nutans* (L.) Polak., *C. texana* Greene, and others. The similarities of *C. tomentosa* and its two closest relatives to the five others here placed in sect. *Chaptalia*, and the apparent geographic integrity of the whole group, are taken here as evidence of close evolutionary relationship (Nesom 1995). A more detailed discussion of this problem is presented in a pair of papers by Katinas and Nesom (submitted).

ACKNOWLEDGMENTS

Loans of specimens to the first author from F, GH, IEB, MEXU, MICH, and USCH are greatly appreciated. We are grateful for helpful reviews from the editor and Beryl B. Simpson.

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BOOK REVIEW

JEREMY D. GARRETT. CORAL MCCALLISTER (Illustrator). 2003. **Landscaping for Wildlife: A Guide to the Southern Great Plains.** (ISBN: 0806134895, pbk.). University of Oklahoma Press, 4100 28th Ave., Norman, OK 73069-8218, U.S.A. (Orders: www.oupress.com, 800-627-7377, 800-735-0476 [orders only], 405-364-5798 fax). $28.00, 209 pp., b/w and color illustrations, 8 1/2" × 11".

From *Landscaping for Wildlife.*—"People want to attract wildlife to their yards for a variety of reasons, but probably foremost among these is that birds and other animals bring us pleasure. The exuberant songs of cardinals and mockingbirds, the playful antics of young squirrels at feeders, and the sight of colorful butterflies dancing above wildflower patches provide us with both daily and lasting joy."

Through careful landscaping, you can make your property a year-round waystation for a wide variety of animal species, from birds, butterflies, and squirrels to bats, turtles, and opossums. Garrett explains how specific plants draw animals to your property by providing food and shelter sources.

To assist readers in designing their own "wildscape," detailed diagrams and plant listings accompany photographs of several Oklahoma Department of Wildlife Conservation-certified wildscaped properties. The detailed diagrams will help you inventory and wildscape your own property. A woodworking chapter is complete with patterns of nesting and feeding stations designed for individual wildlife species. Each section includes tables that list the common name and the scientific name of the plant or wildlife species. The tables discuss how the plants are used or what animal uses them and the relationship between flora and fauna is defined.

The detailed diagrams are especially useful in visualizing what a particular wildscaped plot will look like. Each includes a color photograph, a bird's-eye or plan view and an interpretive sketch on which the plants are identified. The bird's-eye view could be used as a guide for planting. The eleven case studies cover six kinds of settings: sunny, shady, and moist wildscapes, wildflower meadows, and butterfly and rock gardens. All of the case studies illustrate multi-layering and provision of cover.

Water sources rate their own chapter and cover several types. Three types of ponds, a re-circulating stream, and a side yard marsh are illustrated though the use of case studies. Common aquatic and wetland plants are discussed, as well as wetland-related wildlife species.

The appendices provide a design checklist and a monthly activities calendar. Sources for seeds and plants are listed, and there is a bibliography of field guides and references. Internet sites and related organizations and agencies are listed.

Landscaping for Wildlife provides beginners and experts alike with specific, detailed; yet easy-to-follow instructions for meeting water needs, feeding preferences, and nesting requirements of the wildlife found in the southern Great Plains. Although written specifically for the southern Great Plains the concept is one that could be used anywhere with appropriate substitutions for locality. Written by Jeremy D. Garrett in association with the Oklahoma Department of Wildlife Conservation and complemented by Coral McCallister's elegant and charming illustrations of wildlife as well as of various habitats and wildscapes.

The Oklahoma Department of Wildlife Conservation manages Oklahoma's wildlife resources and habitat to provide scientific, educational, aesthetic, economic, and recreational benefits for present and future generations of hunters, anglers, and others who appreciate wildlife. Jeremy D. Garrett is president of NaTour Communications, a nature-consulting firm. Coral McCallister is a biological illustrator for the Department of Zoology at the University of Oklahoma.—*Gary Jennings, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

TAXONOMY OF THE POLEMONIACEAE: THE SUBFAMILIES AND TRIBES

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ABSTRACT

This paper presents a revised formal classification of the subfamilies and tribes of the Polemoniaceae based on a synthesis of new and old characters and on a traditional taxonomic approach. The genera are grouped into nine tribes and three subfamilies (Cobaeoideae, Polemonioideae, Acanthogilioideae). The five tropical and subtropical genera, which are basal in the family, fall into two primary groups: subfam. Cobaeoideae, containing *Cantua*, *Cobaea*, *Bonplandia*, and *Loeselia*; and subfam. Acanthogilioideae, containing *Acanthogilia*. The temperate herbaceous genera, which are derived, also fall into two primary groups. The subfam. Polemonioideae, related to and evidently derived from the Cobaeoideae, contains *Polemonium*, *Collomia*, *Navarretia*, *Phlox*, *Linanthus*, etc. The second main group of temperate herbaceous genera is the tribe Gilieae, which is related to the tribe Acanthogilieae and included in the same subfamily Acanthogilioideae with it. The Gilieae contains the genera *Gilia*, *Eriastrum*, *Ipomopsis*, etc. This system differs in numerous respects from the recent system of Porter and Johnson (Aliso, vol. 19(1), 2000), based on a molecular cladistic approach. Different goals and methods produce different results. It is suggested that other plant groups, which have been revised in recent times according to molecular cladistic evidence and criteria, should also be revised by taxonomic methods. Updated taxonomic classifications are needed for the useful features that they alone provide.

RESUMEN

En este trabajo se presenta una clasificación formal revisada de las subfamilias y tribus de las Polemoniaceae basada en una síntesis de caracteres nuevos y viejos mediante un método taxonómico clásico. Los géneros se agrupan en nueve tribus y tres subfamilias (Cobaeoideae, Polemonioideae, Acanthogilioideae). Los cinco géneros tropicales y subtropicales, que son basales en la familia, quedan en dos grupos primarios: subfam. Cobaeoideae, con *Cantua*, *Cobaea*, *Bonplandia*, y *Loeselia*; y subfam. Acanthogilioideae, con *Acanthogilia*. Los géneros herbáceos templados, que son derivados, también están en dos grupos primarios. La subfam. Polemonioideae, relacionada y evidentemente derivada de Cobaeoideae, contiene a *Polemonium*, *Collomia*, *Navarretia*, *Phlox*, *Linanthus*, etc. El segundo grupo principal de géneros herbáceos templados es la tribu Gilieae, que se relaciona con la tribu Acanthogilieae y está incluida también en la misma subfamilia Acanthogilioideae. Gilieae contiene los géneros *Gilia*, *Eriastrum*, *Ipomopsis*, etc. Este sistema difiere en numerosos aspectos del sistema reciente de Porter y Johnson (Aliso, vol. 19(1), 2000), basado en un método cladístico molecular. Diferentes objetivos y métodos producen resultados diferentes. Se sugiere que otros grupos de plantas, que han sido revisados recientemente con criterios y métodos cladistas moleculares deberían revisarse también por métodos taxonómicos. Las clasificaciones taxonómicas actualizadas se necesitan por las características que sólo ellas pueden ofrecer.

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INTRODUCTION

Research on systematics of the Polemoniaceae is going on in several laboratories at present and is producing new evidence concerning relationships. This paper presents a revised classification of the primary subdivisions of the family—the subfamilies and tribes—in the light of the currently available information.

An earlier system (Grant 1959) was constructed before there was much pollen-morphological evidence or any DNA evidence. Both of these lines of evidence are very important for classification (see Materials and Methods for references). The two types of evidence were used in a recent system (Grant 1998; see Table 1).

I did not appreciate the full potential of the pollen evidence in 1998. It was used there to distinguish groups at low and middle taxonomic levels. In the revised system presented here it is used as a key character separating subfamilies.

An important molecular survey of the family was carried out by Johnson et al. (1996), using the chloroplast gene *matK* and a cladistic approach. This study recognized informal groupings based on the DNA cladograms, many of which differed from those in the Grant (1959) system. I took up some of these new groupings but rejected others in a revised taxonomic classification (Grant 1998, 1999; Grant & Day 1999). The taxonomic system of 1998–1999 differs significantly from the molecular cladistic groupings of Johnson et al. (1996).

Cladistic treatments of other organellar genes were made by various workers in this same period. The studies most relevant to this paper are listed in Materials and Methods. A complete list of molecular studies in the family up to 2000 is given by Porter and Johnson (2000).

Porter and Johnson (2000) then used the available molecular evidence as the main basis for a formal system of the family. The primary clades or deepest branchings in the DNA cladograms become subfamilies in their system, the secondary clades become tribes, and the third-order clades become genera or small sets of genera. Formal taxonomic names are assigned to the groups. Good descriptions of phenetic characters are given for the groups. However, it is difficult to tell what role these phenetic characters play in defining the groups; sets of diagnostic characters are lacking. The groups are basically clades. Porter and Johnson (2000, p. 55) describe their system as "a phylogenetic classification of the Polemoniaceae." It is what Mayr and Bock (2002) call a cladification.

Again, major differences exist between the cladistic system (Porter & Johnson 2000) and the taxonomic system (Grant 1998, 1999; Grant & Day 1999). A detailed analysis and discussion of these differences is given in Grant (2001). The incongruences persist in a comparison of the molecular cladistic system with the revised taxonomic system presented in this paper. Some of the differences are shown in Table 1.

TABLE 1. Comparison of recent classification systems of the family.

Grant 1959	Grant 1998, 1999; Grant and Day 1999
Tropical and subtropical taxa	**Subfam. 1. Cobaeoideae.**
Tribe 1. Cantueae.	**Tribe 1.** Cantueae.
Cantua, Huthia	*Cantua, Huthia.*
Tribe 2. Cobaeeae.	**Tribe 2.** Cobaeeae.
Cobaea.	*Cobaea.*
Tribe 3. Bonplandieae.	**Tribe 3.** Bonplandieae.
Bonplandia, Loeselia.	*Bonplandia.*
Temperate taxa.	**Tribe 4.** Loeselieae.
Tribe 4. Polemonieae.	*Loeselia.*
Polemonium, Collomia, Allophyllum, Gymnosteris, Phlox, Microsteris.	**Tribe 5.** Acanthogilieae.
Tribe 5. Gilieae.	*Acanthogilia.*
Gilia, Ipomopsis, Eriastrum, Langloisia, Navarretia, Leptodactylon, Linanthus.	**Subfam. 2. Polemonioideae.**
	Tribe 6. Polemonieae.
	Polemonium, Collomia, Allophyllum, Navarretia, Phlox, Microsteris, Gymnosteris.
	Tribe 7. Gilieae.
	Gilia, Ipomopsis, Eriastrum, Langloisia, Tintinabulum.
	Tribe 8. Leptodactyloneae.
	Leptodactylon, Linanthus, Maculigilia.

Porter and Johnson 2000	System proposed here (2003)
Subfam. 1. Acanthogilioideae.	**Subfam. 1. Cobaeoideae.**
Tribe 1. Acanthogilieae.	**Tribe 1.** Cantueae.
Acanthogilia.	*Cantua,* (incl. *Huthia*).
Subfam. 2. Cobaeoideae.	**Tribe 2.** Cobaeeae.
Tribe 2. Cantueae.	*Cobaea.*
Cantua (incl. *Huthia*).	**Tribe 3.** Bonplandieae.
Tribe 3. Cobaeeae.	*Bonplandia.*
Cobaea.	**Tribe 4.** Loeselieae.
Tribe 4. Bonplandieae.	*Loeselia.*
Bonplandia.	**Subfam. 2. Polemonioideae.**
Subfam. 3. Polemonioideae.	**Tribe 5.** Polemonieae.
Tribe 5. Polemonieae.	*Polemonium, Collomia, Allophyllum, Navarretia.*
Polemonium.	**Tribe 6.** Phlocideae.
Tribe 6. Loeselieae.	*Phlox, Microsteris, Gymnosteris.*
Loeselia, Giliastrum, Dayia, Bryantiella, Aliciella, Ipomopsis, Microgilia, Eriastrum, Langloisia, Loeseliastrum.	**Tribe 7.** Leptodactyloneae.
Tribe 7. Gilieae.	*Leptodactylon, Linanthus, Maculigilia.*
Collomia, Allophyllum, Navarretia, Gilia, Saltugilia, Lathrocasis.	**Subfam. 3. Acanthogilioideae.**
Tribe 8. Phlocideae.	**Tribe 8.** Acanthogilieae.
Phlox, Microsteris, Gymnosteris, Linanthus, Leptosiphon.	*Acanthogilia.*
	Tribe 9. Gi ieae.
	Gilia, Ipomopsis, Eriastrum, Langloisia, Tintinabulum.

Cladists, on finding differences between cladistic and taxonomic systems of the same group, commonly attribute the differences to inadequacies in the taxonomy. Johnson et al. (1996) expressed this view of the Grant (1959) system very clearly. Indeed, the 1959 system was old and in need of repair in 1996. However, there are also other explanations to consider.

The basic consideration is that one system is a product of taxonomy and the other a product of cladistics. The two approaches have different criteria, goals, and methods. Taxonomy groups organisms according to similarity and difference, cladistics groups them into ancestor-descendant lineages. Taxa are not the same as clades. Taxonomy uses the traditional definition of monophyly whereas cladistics uses a special definition of its own. In taxonomy a monophyletic group is any group of organisms descended from a recent common ancestor; in cladistics a group to qualify as monophyletic must contain all the descendants of the common ancestor (see reviews of Mayr & Bock 2002, and Grant 2003).

The differences in the definition of a systematic unit and of monophyly automatically lead to incongruence between taxonomic and cladistic systems of the same group. A group circumscribed in a given way can be monophyletic in taxonomy but non-monophyletic in cladistics. And cladists frequently and incorrectly declare a taxonomic group to be non-monophyletic when it is monophyletic by the taxonomic definition. Many of the disagreements between the taxonomic and cladistic systems of the Polemoniaceae (and other plant groups) can be attributed to the differences in working concepts and definitions (see Grant 2001, 2003).

Where incongruences between rival systems are due to the use of different working concepts, one system cannot be said to be right and the other wrong; both systems may be right by their own respective standards. The view held by many cladists, including Johnson et al. (1996) in the Polemoniaceae, that a new cladistic treatment should replace a preexisting taxonomic treatment, is not justified insofar as it is based on the working concepts. In fact, one could argue just the opposite. We should have both cladistic systems and up-to-date taxonomic classifications, so that consumers of systematic biology can have a choice.

Other incongruences between taxonomic and cladistic systems of the Polemoniaceae are due to the evidence used. Here we are comparing taxonomy with molecular cladistics, phenetic characters with DNA sequence variation, and broad databases with narrow ones. This aspect will be considered in the Discussion section.

An up-to-date formal taxonomic classification of the Polemoniaceae is needed to complement the valuable cladistic treatment of Porter and Johnson (2000). The present paper deals with the subfamilies and tribes. An updated taxonomic treatment of the genera and sections of the temperate herbaceous Polemoniaceae is also needed. Work has begun on selected temperate genera.

MATERIALS AND METHODS

I compiled a list of conventional taxonomic characters from the older literature. I then sorted out the characters that distinguish groups at higher levels in the family, and set aside those that are diagnostically useful for genera and species. Character expressions were checked in the University of Texas Herbarium where desirable.

Family-wide surveys of particular microscopic and chemical characters are very helpful. Such surveys are available for: chromosomes (Grant 1959, ch. 6); pollen (Stuchlik 1967a, 1967b; Taylor & Levin 1975); wood anatomy (Carlquist et al. 1984); corolla venation (Day & Moran 1986); flavonoids (Smith et al. 1977, 1982); and organellar DNA (several authors listed below). The older studies of chromosomes size (in Grant 1959) need to be repeated by modern methods of determining DNA quantity.

Some of the characters vary at the upper taxonomic levels, and are used in this paper, while others vary at the generic and infrageneric levels. This is illustrated by the flavonoids.

The flavonoids occurring in the family fall into three main groups: (A) the common types, kaempferol, quercetin, and myricetin; (B) 6-methoxyflavonols; and (C) C-glycosylflavones (Smith et al. 1977). Variation in these is more useful taxonomically at the genus level than at the tribal level, and only a part of the flavonoid evidence is included in this paper. Smith et al.'s (1977) findings are recorded below for the four tropical genera. One aspect, the presence or absence of types B and C is recorded below for the temperate tribes.

Numerous features of the pollen show variation within the family. Day and Moran (1986) found that the spatial distribution of the pores is especially useful diagnostically. Most members of the family fall into one or the other of two contrasting character states: pantoporate (pores scattered over the grain) or zonocolporate (pores equatorial).

The corolla tube has five sets of three parallel and separate veins, one set for each corolla lobe. In most members of the family the veins anastomose to form a network in the corolla throat or lobes. In the tribe Leptodactyloneae, however, the veins are non-anastomosing. The character may not be well exhibited in small-flowered species of other tribes (Day & Moran 1986).

Family-wide studies of DNA sequences have been carried out with chloroplasts (*matK*, *ndhF*), mitochondria (*nad1B*), and ribosomes (*ITS*) (Steele & Vilgalys 1994; Johnson et al. 1996; Porter 1997; Porter & Johnson 1998; Prather et al. 2000). The DNA relationships are clearly portrayed in the cladograms, and I have used these in constructing the taxonomic classification. However, I have not found a way to express the molecular evidence in verbal terms for inclusion in the descriptions. The Porter and Johnson (2000) system is a good representation of the molecular clades (see Table 1).

The molecular evidence is often but not always in agreement with the phenetic evidence. In cases of a conflict I reexamine the phenetic evidence with the thought that it is best to have some phenetic characters to support the molecular characters. In the recent past (Grant 1998, 1999) and again for the present study I have found some such correlated phenetic and molecular characters, and have made the appropriate taxonomic changes. If, however, molecular evidence alone points in one direction, while two or more reliable phenetic characters point to a different taxonomic conclusion, I follow the phenetics. In other words, I do not assume that the molecular evidence is always the right guide to follow.

The descriptions in the formal system consist mainly of the character states of diagnostic characters. These can be regarded as the evidence supporting the taxonomic groupings. Good complete descriptions are given by Porter and Johnson (2000).

The nomenclatural paragraphs of the subfamilies and tribes contain the essential original names and recent names. Additional synonyms may be found in Grant (1959).

SYSTEM OF CLASSIFICATION

Fam. Polemoniaceae Juss. Polemoniaceae (as Polemonia) Juss.; Gen. Pl. 136. 1789. TYPE: *Polemonium caeruleum* L.

Various life forms from small trees to annual herbs. Leaves mostly alternate, but opposite in *Phlox*, *Leptodactylon*, and *Linanthus*. Floral plan 5-5-5-3. Corolla sympetalous with epipetalous stamens, usually radial, sometimes bilateral. Corolla veins mostly anastomosing in the corolla throat or lobes, but non-anastomosing in *Leptodactylon* and *Linanthus*. Ovary superior and 3-carpellary. Fruit generally a 3-celled capsule, but 1- or 2-celled in some species of *Navarretia*. Original basic number $x = 9$; polyploids and aneuploids common.

Mainly American hemisphere; several species in Eurasia. About 347 species. These are grouped here into three subfamilies and nine tribes. The species are listed for the tropical and subtropical tribes and genera. This is not feasible for the species-rich temperate groups; for these see the species lists in Grant (1959) and Porter and Johnson (2000).

ANALYTICAL KEY TO TRIBES

1. Seeds mostly winged (sometimes wingless); chromosomes small; tropical and subtropical.
   2. Spiny desert shrub; deciduous green leaves in axils of spines; pollen zonocolporate; endemic in Baja California _____ **Acanthogilieae**
   2. Not spiny desert shrubs with leaves as above; pollen pantoporate; widespread in American tropics and subtropics.
      3. Calyx wholly herbaceous; individual flowers not subtended by bracts; life form varies.

4. Climbing vines; calyx sepals divided to base; leaves with terminal tendrils _____ **Cobaeeae**
4. Not vines; calyx synsepalous; leaves without tendrils.
5. Small trees and shrubs; Andes _____ **Cantueae**
5. Perennial herbs; Mexico and Guatemala _____ **Bonplandieae**

3. Calyx membranous with no or only small herbaceous regions; individual flowers subtended by bracts; shrubs and herbs _____ **Loeselieae**

1. Seeds without wings; chromosomes mostly medium-sized to large, but small in 1 tribe; temperate and boreal.
6. Pollen zonocolporate; seeds sandy or pale-colored; mostly in xeric habitats, common in deserts _____ **Gilieae**
6. Pollen pantoporate; seed color varies; in various habitats.
7. Seeds sandy or pale-colored; leaves opposite; leaves if cleft or divided are palmately so; chromosomes small _____ **Leptodactyloneae**
7. Seeds dark brown or black; leaves alternate or opposite; leaves if divided are pinnately so; chromosomes large or medium-sized.
8. Leaves alternate; leaves pinnately compound or lobed _____ **Polemonieae**
8. Leaves opposite, or absent in 1 small genus; leaves simple and entire _____ **Phlocideae**

Subfam. 1. Cobaeoideae (D. Don) Arn., Cobaeaceae D. Don, Edinburgh Philos. J. 10:109–111. 1824. Subfam. Cobaeoidea Arn., Encycl. Brittanica, ed. 7, 5:121. 1832. Subfam. Cobaeoideae Brand, Pflzr. 4(250):19. 1907. TYPE: *Cobaea scandens* Cav.

Various life forms from small trees to herbs, in tropical and subtropical zones. Seeds mostly winged, sometimes wingless. Pollen pantoporate. Chromosomes small.

Tribe 1. Cantueae Peter, Nat. Pflazfam. 4(3a):45. 1891. TYPE: *Cantua buxifolia* Juss.

Small trees and shrubs. Leaves simple with broad blade or pinnately divided and narrow. Calyx wholly herbaceous and synsepalous. Corolla radial to bilateral. Seeds flat with broad wings. All three groups of flavonoids (A, B, and C) present (see Materials and Methods for explanation of these groups). $2n = 54$.

Distribution and taxa.—Andes. One genus, *Cantua*, with twelve species: *C. bicolor*, *C. buxifolia*, *C. candelilla*, *C. coerulea*, *C. cuzcoensis*, *C. flexuosa*, *C. longiflora*, *C. longifolia*, *C. ovata*, *C. pyrifolia*, *C. quercifolia*, *C. tomentosa*. The former small genus *Huthia* has been submerged in *Cantua* by Porter and Johnson (2000) and Alan Prather (pers. comm.) who is currently studying the group. I am following these authors.

Tribe 2. Cobaeeae (D. Don) Meisn., Cobaeaceae D. Don, Edinburgh Philos. J. 10:109–111. 1824. Tribe Cobaeeae Meisn., Pl. Vasc. Gen. 180, 273. 1839–1840. TYPE: *Cobaea scandens* Cav.

Climbing vines. Leaves pinnately compound with a terminal tendril. Flowers large and solitary. Calyx wholly herbaceous, sepals divided to base. Corolla radial. Seeds flat with broad wings. Has flavonoids of type A only. $2n = 52$.

Distribution and taxa.—Tropical forests from Mexico to Peru. One genus, *Cobaea*, with four sections and eighteen species: *C. aequatoriensis*, *C. ascher-*

soniana, *C. biaurita*, *C. campanulata*, *C. flava*, *C. gracilis*, *C. lutea*, *C. minor*, *C. pachysepala*, *C. paneroi*, *C. penduliflora*, *C. pringlei*, *C. rotundiflora*, *C. scandens*, *C. skutchii*, *C. stipularis*, *C. trianae*, *C. triflora*. See the recent monograph of Prather (1999).

Tribe 3. Bonplandieae Baill., Hist. Pl. 10:342. 1890. TYPE: *Bonplandia geminiflora* Cav.

Subshrubs with woody base and herbaceous shoot. Leaves simple with a broad blade and serrate margin or lobed. Calyx wholly herbaceous and synsepalous. Corolla bilateral. Seeds plump with narrow wings or wingless. Has flavonoids of type B only. $2n = 30$.

Distribution and taxa.—Mexico and Guatemala. One genus, *Bonplandia*, with two species, *B. geminiflora* and *B. linearis*.

Tribe 4. Loeselieae J.M. Porter & L.A. Johnson, Aliso 17:84. 8 Jun 1998. Tribe Loeselieae V.E. Grant; Amer. J. Bot. 85:744. 17 Jun 1998. TYPE: *Loeselia ciliata* L.

Subshrubs, perennial herbs, and annuals. Leaves simple with broad blade and entire or serrate margin. Inflorescence bracts with prominent veins subtend individual flowers; these are usually large and leaflike, but may be small. Calyx synsepalous and membranous with no or only small herbaceous regions. Corolla radial or bilateral. Seeds with narrow wings or wingless. Flavonoid groups A and C present, but type B absent. $2n = 18$.

Distribution and taxa.—Mexico to southern Texas and Arizona and to northern South America. Often in the temperate zone of tropical mountains. One genus, *Loeselia*, with fifteen species: *L. amplectens*, *L. caerulea*, *L. ciliata*, *L. cordifolia*, *L. glandulosa*, *L. grandiflora*, *L. greggii*, *L. hintoniorum*, *L. involucrata*, *L. mexicana*, *L. nepetifolia*, *L. pumila*, *L. purpusii*, *L. rupestris*, *L. rzedowski*. See Turner (1994) for a recent generic treatment.

Subfam. 2. Polemonioideae Brand., Pflzr. 4(250):30. 1907. TYPE: *Polemonium caeruleum* L.

Subshrubs, perennial herbs, and annuals, of temperate and boreal zones. Seeds not winged. Pollen pantoporate. Chromosomes mostly large or medium-sized, but small in one tribe.

Tribe 5. Polemonieae Arn., Encycl. Brittanica, ed. 7, 5:121. 1832. Tribe Polemonieae Meisn., Pl. Vasc. Gen. 273. 1839. TYPE: *Polemonium caeruleum* L.

Perennial and annual herbs. Leaves alternate. Leaves pinnately compound (in *Polemonium*) or simple and pinnately lobed, or simple and entire in reduced forms (in the other genera). Capsule locules commonly containing 1 to few seeds each; sometimes many-seeded in *Navarretia*. Seeds dark brown or black, sometimes plump and rounded, sometimes small. Pollen generally pantoporate, but

zonocolporate in some species of *Collomia*. Flavonoids of type C absent; type B absent in *Polemonium* and *Allophyllum*, but present in *Collomia* and *Navarretia*. Chromosomes medium-sized or large, $x = 9$ and 8.

Distribution and taxa.—North America, extending to Eurasia. Genera: *Polemonium*, *Collomia*, *Allophyllum*, *Navarretia*. About 78 species.

Polemonium is set apart from the other three genera by leaf form and some molecular characters (Johnson et al. 1996). It could well be separated in a tribe of its own, as in the Porter and Johnson (2000) system. On the other hand, it is allied to the other genera by seed and pollen characters and by other molecular evidence (Prather et al. 2000). A conservative disposition is made here.

Tribe 6. Phlocideae Dumort., Anal. Fam. Pl., 25. 1829. Gruppe Phloginae Rchb., Handb. Nat. Pflzsystems, ed. 1, 194. 1837. Tribe Phlogieae Rohb. ex J.M. Porter & L.A. Johnson, Aliso 17:84. 1998. TYPE: *Phlox glaberrima* L.

Subshrubs, perennial herbs, and some annuals. Leaves or at least the lower leaves opposite; true leaves absent in the small genus *Gymnosteris*. Leaves simple with narrow blade and entire margin. Capsule locules mostly 1-seeded. Seeds brown, sometimes plump and rounded, sometimes small. Flavonoids of type B lacking, but type C present. Chromosomes medium-sized or large, $x = 7$ and 6.

Distribution and taxa.—North America, extending to Asia. Genera: *Phlox*, *Microsteris*, *Gymnosteris*. About 66 species.

Phlox (x = 7) could be derived from *Collomia* (x = 8) in the Polemonieae. *Microsteris* (x = 7) is a reduced annual derived from a perennial *Phlox*. *Gymnosteris* ($x = 6$) is a reduced leafless annual formerly thought to be close to *Collomia*; but phenetic and molecular evidence now indicate that its closest relative is *Phlox* or *Microsteris* (Porter & Johnson 2000). See Ferguson and Jansen (2002) on molecular relationships in *Phlox*.

Tribe 7. Leptodactyloneae V.E. Grant, Amer. J. Bot. 85:746. 1998. TYPE: *Leptodactylon californicum* Hook & Arn.

Subshrubs, perennial herbs, and annuals. Leaves mostly opposite. Leaves palmately divided, or simple and entire in reduced forms. Corolla veins non-anastomosing, in contrast to other tribes (see explanation in Materials and Methods). Capsule locules containing several to many seeds each, rarely 1-seeded. Seeds sandy or pale-colored, or sometimes brown in *Leptodactylon*. Flavonoids of types B and C present. Chromosomes small, $x = 9$.

Distribution and taxa.—Semiarid and arid habitats including deserts in western North America. Genera: *Leptodactylon*, *Linanthus*, *Maculigiia*. About 50 species.

In the system of Porter and Johnson (2000), *Linanthus* s.l. is subdivided into two genera, *Linanthus* s.s. and *Leptosiphon*, on cladistic grounds. These two taxa are indeed well differentiated, but they are also united by some common characters, and they could be treated as either subgenera of one genus or two

separate genera. A conservative treatment as *Linanthus* s.l. is preferred here because it shows the relationships of the two branches. *Maculigilia* is a recent segregate genus for the old distinctive desert species *Gilia maculata* (see Patterson 1989; Grant 1999). *Maculigilia maculata* is probably a derivative of some xerophytic member of *Linanthus*.

Leptodactylon and *Linanthus* form a closely related and isolated genus pair. This group was formerly placed in the tribe Gilieae on macroscopic characters (Grant 1959), but the more recent evidence of flavonoids and *cpDNA* and *nrDNA* point to a relationship with *Phlox* (Smith et al. 1977, 1982; Johnson et al. 1996; Porter 1997). *Leptodactylon/Linanthus* is placed in the tribe Phlocideae in the Porter and Johnson (2000) system.

However, in other characters, *Leptodactylon* and *Linanthus* are unlike the Phlocideae (or Polemonieae); namely, palmate leaves, non-anastomosing corolla veins, sandy or pale-colored seeds, small chromosomes, and an affinity for semiarid and arid habitats. The present treatment attempts to resolve the similarities and important differences by placing these genera in a separate tribe Leptodactyloneae next to the Phlocideae. This makes for a better definition of both tribes.

Subfam. 3. Acanthogilioideae (V.E. Grant) J.M. Porter & L.A. Johnson, Aliso 19:60. 2000. Tribe Acanthogilieae V.E. Grant; Amer. J. Bot. 85:744. 1998. TYPE: *Gilia gloriosa* Brand., *Acanthogilia gloriosa* A.G. Day & R. Moran.

Shrubs, subshrubs, and herbs of arid habitats, commonly in deserts. Seeds winged or wingless. Pollen zonocolporate. Chromosomes mostly medium-sized or large, but small in one tribe.

Tribe 8. Acanthogilieae V.E. Grant, Amer. J. Bot. 85:744. 1998. TYPE: *Gilia gloriosa* Brand., *Acanthogilia gloriosa* A.G. Day & R. Moran.

Spiny desert shrub. Leaves dimorphic, with primary leaves modified as persistent spines, and small deciduous green leaves in the axils of the spines. Capsule locules containing 1–6 seeds each. Seeds flat with broad wings. Chromosomes small, $x = 9$.

Distribution and taxa.—Endemic in central Baja California. One genus and species *Acanthogilia gloriosa*. Detailed information about this interesting taxon is given by Day and Moran (1986).

Tribe 9. Gilieae (Rchb.) V.E. Grant, Nat. Hist. Phlox Fam. 120. 1959. Gruppe Gilieae Rchb.; Handb. Nat. Pflzsystems, ed. 1, 194, 1837. Tribe Gilieae J.M. Porter & L.A. Johnson; Aliso 19:63. 2000. TYPE: *Gilia laciniata* Ruiz & Pav.

Subshrubs, perennial herbs, and annuals; not spiny. Leaves not dimorphic; leaves pinnately divided or dissected with narrow segments, or small and linear in reduced forms. Capsule locules usually many-seeded. Seeds sandy or pale-colored, mostly angular, sometimes banana-shaped. Pollen generally

zonocolporate, but deviating toward pantoporate in some species of *Eriastrum*. Flavonoids of type B present; type C uncommon (occurs in *Gilia* and *Langloisia*) or absent (*Gilia*, *Ipomopsis*). Chromosomes mostly medium-sized, sometimes large; $x = 9$, 8, and 7.

Distribution and taxa.—Widespread in arid habitats, common in deserts. The genera as treated here are *Gilia*, *Tintinabulum*, *Ipomopsis*, *Eriastrum*, *Langloisia*. About 105 species.

A broad concept of *Gilia* as a genus composed of six sections is adopted here and elsewhere (Grant 1999, 2001). Gilia s.l. with a basic chromosome number of $x = 9$ in all sections (and $x = 8$ in part of one section) is basal in the tribe. *Tintinabulum* ($x = 9$) is a small specialized genus close to *Gilia*. *Ipomopsis*, *Eriastrum*, and *Langloisia* with $x = 7$ appear to be derivatives of *Gilia* (Grant 2001).

Molecular cladists consider *Gilia* s.l. to be polyphyletic, and split it up into a series of small genera (Johnson et al. 1996; Porter & Johnson 2000). I contend that this viewpoint is based, first, on the cladistic definition of monophyly and, second, on an overreliance on the molecular cladograms, and that *Gilia* s.l. is monophyletic by the traditional definition of monophyly (Grant 1999, 2001).

PHYLOGENY

The Polemoniaceae is evidently derived from an ericalean stock (Brown 1938; Porter & Johnson 1998; Johnson et al. 1999). The basal living forms of the family are the tropical and subtropical genera. There are five of these (*Cantua*, *Cobaea*, *Bonplandia*, *Loeselia*, *Acanthogilia*), all very different from one another. In this group *Cantua* comes closest to the ericalean stock, while the other genera exhibit derived characters of one sort or another.

The subtropical desert shrub, *Acanthogilia*, differs markedly from *Cantua*, but also shares some inconspicuous but significant characters with it (Day & Moran 1986). These workers suggest (p. 125) that "*Acanthogilia* may be a specialized desert descendant of a diploid line also ancestral to *Cantua*."

One of the significant characters is the spatial distribution of pores on the pollen grains, whether pantoporate or zonocolporate. Another is ecological preferences: mesic or xeric. The pollen pore character has proven to be a valuable marker for revising the classification of species groups and genera (Day & Moran 1986; Grant & Day 1999), and can be extended to higher taxa. *Cantua* and three related genera (*Cobaea*, *Bonplandia*, and *Loeselia*, comprising the subfamily Cobaeoideae) are pantoporate and mesophytic. *Acanthogilia* is zonocolporate and xerophytic. Day and Moran's (1986) hypothesis can be rephrased as the suggestion of an early split between the ancestors of the pantoporate Cobaeoideae and the ancestor of the zonocolporate *Acanthogilia*. The molecular evidence of Prather et al. (2000) is in agreement with this hypothesis.

This split persists in the derived, temperate, mainly herbaceous tribes. Day

and Moran (1986) point to characters which *Gilia* and its close relatives share with *Acanthogilia*. The tribe Gilieae, as circumscribed here and in Grant (1998), is zonocolporate and xerophytic. It could well have an unknown ancestor in common with *Acanthogilia*.

The mid-Eocene plant *Gilisenium* from Utah is close to *Gilia* in a number of characters (Lott et al. 1998). It is desirable to determine its pollen pore character, if possible.

The tribes Polemonieae and Phlocideae are pantoporate and generally mesophytic. They may be derived from a *Bonplandia*-like ancestor in the Cobaeoideae. The Polemonieae and Phlocideae extend into cold northern areas and are the only representatives of the family in northeastern North America and Eurasia. The Leptodactyloneae is also pantoporate and is related to the Phlocideae but is xerophytic.

The two main temperate phylads often occur in the same area, especially in western North America, where some species or groups have crossed over from one type of habitat to another. In this situation the two phylads have given rise to species of annuals which converge in their general morphological characters. For example, some small-flowered species of *Allophyllum* (Polemonieae) closely resemble certain small-flowered species of *Gilia* (Gilieae), and were mistakenly treated as *Gilia* until recently (Grant 1999; Grant & Day 1999).

DISCUSSION

Several causal factors contribute to the numerous differences between the taxonomic and molecular cladistic systems of the Polemoniaceae. Two of these are theoretical: (1) the use of different systematic units, namely, taxa and clades; and (2) the application of different definitions of monophyly. These two factors were discussed in the introduction. The two approaches also use different evidence and this of course leads to different results. We will consider here: (3) differences in the types of characters used; and (4) differences in the range and breadth of the database.

(3) Molecular systematists working in the Polemoniaceae (and other plant groups) use DNA sites in chloroplasts and mitochondria, which are parts of the cytoplasmic genome. Phenetic characters used in taxonomy are determined mainly by the chromosomal genome (see Grant 1975, 2003, for review). Discordance between plastid and mitochondrial evidence, on the one hand, and phenetic characters on the other, can be expected and is often found. Ribosomes, also used in molecular systematics of Polemoniaceae and other families, are a part of the chromosomal genome. They can vary independently of plastids and mitochondria, and for that matter, independently of unlinked chromosomal genes. Here again, incongruence between the various sources of evidence can be expected (see Grant 2003, for further discussion).

(4) Molecular cladistic treatments of the Polemoniaceae (and those of other

plant groups) are based on one or a few genes. The treatment of Johnson et al. (1996) blocks out informal systematic groups on the basis of one chloroplast gene. Taxonomic systems, by contrast, are based on numerous phenetic characters determined by scores or hundreds of genes and gene systems (Grant 1975, for review). These contrasts between approaches represent the extremes. Modern taxonomists utilize the DNA evidence of molecular systematists. And many molecular cladists incorporate phenetic characters in reaching their conclusions.

Factors (1) and (2) bring about different results but do not affect the accuracy of the results, as noted in the introduction. The type and range of characters (factors 3 and 4) do have an effect on the robustness of the results. Molecular cladograms are essentially gene trees, or character phylogenies to use an older term. Single characters often work well in one part of a group but break down elsewhere in the same group. If the goal is a natural classification of whole organisms, one must assemble a broad range of characters, some of which may conflict with others, and one should then follow the weight of the evidence, as is standard procedure in taxonomy.

Taxonomic classifications thus have certain methodological advantages. Another advantage lies in the area of convenience and desirability. Named similarity groups, and hierarchies of such groups, are generally useful for identification, information retrieval, and cataloging. It would be difficult to write a flora, using clades instead of taxa, and such a flora would be difficult to use if it were written (see Diggs & Lipscomb 2002).

For several reasons, therefore, it is desirable to make an updated taxonomic classification of the Polemoniaceae available. But why stop with the Polemoniaceae. Numerous other plant groups have been revised recently by molecular cladistic methods, but are represented in the literature by old taxonomic treatments. These groups should also be re-revised by taxonomists, using the new molecular evidence, but handling all the evidence by taxonomic methods. Plant taxonomy has much work to do.

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BOOK NOTICES

MILO I. HARPSTEAD, THOMAS J. SAUER, and WILLIAM F. BENNETT. 2001. **Soil Science Simplified, 4th edition.** (ISBN 0-8138-2942-9, hbk.). Iowa State Univ. Press, 2121 South State Ave., Ames, Iowa 50014, U.S.A (Orders: 800-862-6657, www.isupress.com). $42.95, 225 pp., numerous b&w drawings and half-tones, 6" × 9".

This book is suitable as an undergraduate text or as a reference for biologists or other scientists not trained in soil science. It systematically covers the physical, biological and chemical properties of soils; soil formation, soil water, heat flow, and fertility; soil classification and surveys; and soil management, conservation, and engineering. I found the chapters on soil colloids and chemistry, soil classification, and soil surveys the most helpful in interpreting soil maps and characteristics. The different types of clays and their characteristics are explained. Also, the various word roots, prefixes and suffixes used in the names of soil classes and subclasses are explained. It includes a glossary and index.

The weakest aspect of the book is the quality of the illustrations. In many figures, the lines are excessively heavy, black, and run-together. Many of the drawings are not well-executed and fail to show the described features. As a result, much space is wasted that could have been better used by replacing with text or photographs.—*Roger W. Sanders, Associate Collections Manager, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., rsanders@brit.org.*

WILHELMINA FEEMSTER JASHEMSKI and FREDERICK G. MEYER (eds.). 2002. **The Natural History of Pompeii.** (ISBN 0-521-80054-4, hbk.). Cambridge University Press, The Edinburgh Building, Cambridge CB2 2RU, UK; 100 Brook Hill Drive, West Nyack, NY 10994-2133, U.S.A. (Orders: 845-353-7500, 845-353-4141 fax, http://www.cup.org/). $170.00, 502 pp., 387 figs. (b/w, color, drawings, etc.), 9" × 12".

From the dustjacket.—"This volume brings together the work of geologists, soil specialists, paleobotanists, botanists, paleontologists, biologists, chemists, dendrochronologists, ichthyologists, zoologists, ornithologists, mammologists, herpetologists, entomologists, and archaeologists, affording a thorough picture of the landscape, flora and fauna of the ancient sites. The detailed and rigorously scientific catalogues, which are copiously illustrated, provide a checklist of the flora and fauna upon which future generations of scholars can continue to build."

The catalogue of plants by Wilhelmina F. Jashemski, Frederick G. Meyer, and Massimo Ricciardi enumerates and discusses in detail 184 plants. The chapter is 101 pages. The evidence for the plant list comes primarily from the urban sites Pompeii and Herculaneum, and a few villas, which give a good picture of the popular ornamental plants that adorned the many home gardens, parks, and other public places, as well as plants that had religious significance and those used for medicine and other purposes, especially food. There is an extensive list of references. This is an impressive work that will be of interest a variety of audiences.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

A SYNOPSIS OF *MACHAERANTHERA* (ASTERACEAE: ASTEREAE), WITH RECOGNITION OF SEGREGATE GENERA

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ABSTRACT

Recent investigations of *Machaeranthera* s.l. incorporating molecular, morphological, cytological, and chemical evidence have supported relationships that do not conform to any recent circumscription of the genus. To bring the classification of *Machaeranthera* more in line with current understanding of its evolutionary history, revisions to its taxonomy are proposed. *Machaeranthera* is circumscribed to include two species, and other species that have been included in *Machaeranthera* are apportioned into three additional genera. *Dieteria* is revived to accommodate three of these species, *Xanthisma* is expanded to accomodate 16 more species, and the new genus *Arida* is proposed for those remaining. New combinations for the species in *Dieteria*, *Xanthisma*, and *Arida* are provided.

RESUMEN

Investigaciones recientes en *Machaeranthera* s.l. que incluyen datos moleculares, morfológicos, citológicos, y químicos dan como resultado unas relaciones que no concuerdan con ninguna circunscripción reciente del género. Para poner la clasificación de *Machaeranthera* más en línea con el conocimiento actual de su historia evolutiva, se proponen revisiones de su taxonomía. *Machaeranthera* se circunscribe para incluir dos especies, y otras especies que se habían incluido en *Machaeranthera* se redistribuyen en tres géneros adicionales. *Dieteria* se rescata para acomodar tres de estas especies, *Xanthisma* se expande para incluir 16 especies más, y se propone el nuevo género *Arida* para las restantes. Se realizan las nuevas combinaciones para las especies de *Dieteria*, *Xanthisma*, y *Arida*.

The genus *Machaeranthera* Nees (Asteraceae: Astereae) was established to accommodate the single species *M. tanacetifolia* Nees. Since its inception, many different circumscriptions of *Machaeranthera* have been proposed, and the genus has included various parts of several other genera, with little agreement on its composition or its relationships with other taxa (see Morgan and Simpson 1992 for a more detailed taxonomic history).

The most recent published treatment of *Machaeranthera* was by Hartman (1990), who included 36 species in the genus, excluding several taxa that are now placed in the genera *Hazardia* Greene (Hartman 1990), *Rayjacksonia* R.L. Hartman & M.A. Lane (Lane & Hartman 1996), *Tonestus* A. Nelson (Nesom 1991), and *Xylorhiza* Nutt. (Hartman 1990). The circumscription of *Machaeranthera* adopted by Hartman (1990) included species with both cyanic (white, blue, pink, purple) and yellow rays, and apportioned them into two subgenera and eight sections. We will refer to this circumscription as *Machaeranthera* s.l.

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Investigations of *Machaeranthera* s.l. using molecular evidence have helped to clarify its systematics. Restriction site data from chloroplast DNA (cpDNA) indicated that *Machaeranthera* section *Psilactis* (A. Gray) Turner & Horne was not a close relative of *Machaeranthera* s.l. (Morgan & Simpson 1992; Morgan 1993). This section was removed from *Machaeranthera* s.l. by Morgan (1993), leaving 30 species in the genus. More recent investigations of *Machaeranthera* (sensu Morgan 1993) employed DNA sequence data from nuclear ribosomal DNA internal and external transcribed spacers (nrDNA) (Morgan 1997; Morgan 2003). Comparison of this evidence with cpDNA data indicated that the evolution of *Machaeranthera* and its relatives has been complex, involving as many as seven occurrences of reticulate evolution. The molecular evidence also indicated that other genera (e.g., *Oönopsis* Nutt., *Pyrrocoma* Hook., and *Xanthisma* DC.) are closely related to various parts of *Machaeranthera* (Fig. 1).

The relationships supported by a combination of molecular, morphological, cytological, and chemical evidence do not support any recent circumscription of *Machaeranthera*. Therefore, a new classification is needed to bring the taxonomy of the genus more in line with current understanding of its relationships. A case could be made for including *Oönopsis* and *Pyrrocoma* in an expanded *Machaeranthera*, and cpDNA evidence provides some support for such a treatment (Fig. 1). However, nrDNA data do not support this circumscription (Fig. 1). Furthermore, we contend that enlarging *Machaeranthera* through accretion would obscure the phylogenetic patterns within the complex, and would result in a large, heterogenous, and unwieldy genus that would be difficult to characterize satisfactorily. We therefore propose that *Machaeranthera* (sensu Morgan 1993) be divided into four genera, as described below.

KEY TO THE GENERA TREATED HERE

1. Ray floret corollas yellow (heads radiate) _____ **Xanthisma**
1. Ray floret corollas white (sometimes yellowish on drying), pink, red-purple, or purple, or heads eradiate.
   2. Leaves deeply pinnatifid to bipinnatifid throughout, at least many of the teeth and lobes sharply acute with bristle tips, bristles 0.2–1 mm long; plants annual; pappus of subulate bristles, dorsi-ventrally flattened near base, bases overlapping _____ **Machaeranthera**
   2. Leaves entire to toothed or lobed, if pinnatifid to bipinnatifid throughout then lobes often rounded, with or without an apiculum but not bristle tipped; plants annual to strongly perennial; pappus of filiform to subulate bristles, terete to flattened near base, bases overlapping or not overlapping.
      3. Plants strongly perennial with a branched caudex (taprooted, sometimes biennial in *Xanthisma gymnocephalum*, central Mexico); receptacles covered with scales 0.3 3 mm long, often forming an alveolate reticulum; pappus bristles subulate, flattened near base, bases strongly overlapping _____ **Xanthisma**
      3. Plants taprooted annuals or short lived perennials (forming vegetative rosettes in *Arida blepharophylla*, a species also exceptional, as indicated, in the following characters); receptacles usually naked (or scales rarely to 0.5 mm

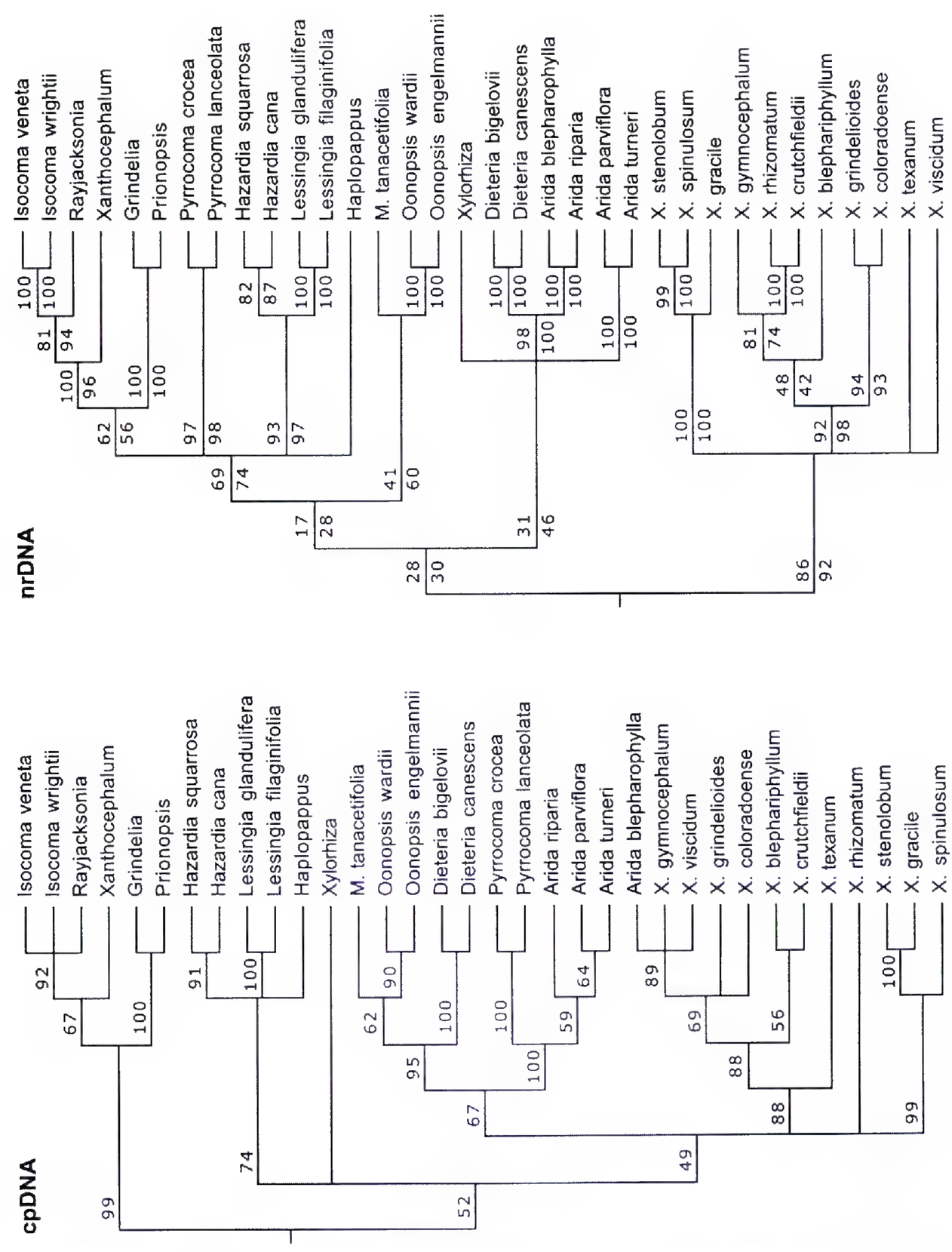


FIG. 1. Strict consensus trees resulting from analysis of chloroplast DNA restriction site data (cpDNA) and combined ITS and ETS sequence data (nrDNA) of *Machaeranthera* and related taxa, from Fig. 3 of Morgan (2003) with modified nomenclature. Bootstrap percentages are shown above and below the branches; values above the branches on both phylogenies are from unweighted bootstrap analysis, and values below the branches on the nrDNA phylogeny are from analyses in which transversions were weighted two times transitions. Generic names for the species of *Machaeranthera* sensu Morgan (1993) conform to the treatment proposed in this paper. Genus names for species of *Machaeranthera* and *Xanthisma* are abbreviated "M." and "X.," respectively.

long); pappus bristles filiform, not flattened near base (or slightly so), bases not (or slightly) overlapping.

4. Ray florets with prominent pappus (often eradiate in the glandular-pubescent *D. canescens* var. *shastensis*); leaves entire to toothed and plants variously pubescent with glandular and/or nonglandular hairs; mountains, plains, and basins of W U.S.A.; SW Canada; extreme N Mexico _____ **Dieteria**

4. Ray florets with pappus absent (5 species; eradiate in the glabrous *A. carnosa*) or present; if pappus present then leaves pinnatifid to bipinnatifid throughout or (if leaves entire to toothed) plants glabrous except for bristles or apiculate or bristle tipped teeth on leaf margins; deserts of SW U.S.A.; Mexico _____ **Arida**

Machaeranthera Nees, Gen. & Sp. Asterearum 224. 1832. TYPE: *Aster tanacetifolius* Kunth.

Chrysopsis subgenus *Pappochroma* Nutt., J. Acad. Nat. Sci. Phila. 7:34. 1834. *Dieteria* subgenus *Pappochroma* (Nutt.) Nutt., Trans. Amer. Philos. Soc. 7:302. 1840. *Dieteria* section *Pappochroma* (Nutt.) Walpers, Rep. Bot. Syst. 2:587. 1843. TYPE: *Chrysopsis coronopifolia* Nutt.

Aster section *Machaeranthera* (Nees) Benth. & Hook., Gen. Pl. 2:272. 1873. *Aster* subgenus *Machaeranthera* (Nees) A. Gray, Proc. Amer. Acad. Arts 16:99. 1880.

Machaeranthera series *Verae* Cronquist & D.D. Keck, Brittonia 9:238. 1957, nom. illeg. (ICBN: 52.1).

Herbs taprooted annuals or biennials, 5–100 cm tall. **Stems** erect to ascending, much branched when well developed, moderately to densely pubescent with glandular and nonglandular hairs. **Leaves** alternate; pinnatifid or bipinnatifid, deeply lobed or dissected, moderately to densely pubescent with glandular and nonglandular hairs, apices, including lobes and teeth, mucronate to bristle tipped, bristles if present 0.2–1 mm long. **Heads** radiate. **Involucres** broadly turbinate to hemispheric. **Phyllaries** in 3–6 imbricate series, graduated in length, appressed, spreading, or reflexed, moderately to densely pubescent with glandular and nonglandular hairs; bases indurate, apices herbaceous. **Receptacles** alveolate, flat to convex, naked or with scales to 0.4 mm long. **Ray florets** pistillate, fertile; corollas blue, violet, or purple. **Disc florets** bisexual, fertile, corollas yellow, narrowly funnelform; tubes and limbs glabrous or glabrate, lobes 0.3–1 mm long, glabrous to pubescent. **Cypselae** of ray and disc florets distinctly dimorphic, narrowly to broadly obovate, sparsely to densely pubescent; moderately thick walled, with 4–9 ribs per face, 2.4–3.8 mm long, those of ray florets ~3 sided, rounded abaxially, of disc florets somewhat compressed laterally; pappus white to tawny, of ray florets 1/2 to nearly equalling length of disc florets; bristles coarsely barbellate, in 1–3 series, dorsi-ventrally flattened and dissimilar in width near base, bases overlapping, mostly 4.5–6.5 mm long. $n = 4$.

The circumscription of *Machaeranthera* adopted here results in a genus of two species. We apportion the remaining 28 species of *Machaeranthera* (sensu Morgan 1993) to *Dieteria*, *Xanthisma*, and *Arida* (see below). The three species placed in *Dieteria* could potentially also be included in *Machaeranthera* because of a number of similarities. All members of the two genera produce flavonols, and all have chromosome numbers of $n = 4$, obovate fruits, and nar-

row phyllaries that are often reflexed (Hartman 1976, 1990; Turner 1987). This relationship was also supported by cpDNA evidence (Fig. 1). However, nrDNA evidence conflicted with cpDNA (Fig. 1), and the substantial conflict between them complicates the issue by suggesting reticulate evolution in the ancestors of *Machaeranthera*, *Dieteria*, or both. In addition, cpDNA and nrDNA evidence both supported a close relationship between *Machaeranthera* and *Oönopsis*, and expansion of *Machaeranthera* to include *Dieteria* would also have to include *Oönopsis*, which differs from *Machaeranthera* in many ways (Morgan & Simpson 1992). Additional synonymy for *Machaeranthera* is included in Turner (1987).

KEY TO THE SPECIES OF *MACHAERANTHERA*

1. Involucres hemispheric; herbaceous phyllary apices spreading to reflexed; disc corolla lobes mostly 0.3–0.7 mm long, glabrous or glabrate _____ **1. Machaeranthera tanacetifolia**

1. Involucres broadly turbinate; herbaceous phyllary apices appressed; disc corolla lobes mostly 0.7–1 mm long, pubescent _____ **2. Machaeranthera tagetina**

1. Machaeranthera tanacetifolia (Kunth) Nees, Gen. & Sp. Asterearum 225. 1832. *Aster tanacetifolius* Kunth, Nov. Gen. & Sp., ed. folio, 4:74. 1820. *Aster chrysanthemoides* Willd. ex Spreng., Syst. Veg. 3:538. 1826. TYPE: MEXICO: "Colitur in horto Mexicano," s.d., *Humboldt s.n.* (HOLOTYPE: P nv., IDC microfiche 6209. 97.III.6; possible ISOTYPE: B-W; PHOTOISOTYPE: TEX!).

Chrysopsis coronopifolia Nutt., J. Acad. Nat. Sci. Phila. 7:34. 1834. *Dieteria coronopifolia* (Nutt.) Nutt., Trans. Amer. Philos. Soc., ser. 2, 7:302. 1840. *Machaeranthera coronopifolia* (Nutt.) A. Nelson, Bot. Gaz. 37:268. 1904. TYPE: U.S.A. NORTH DAKOTA: "Towards the sources of the Missouri" (probably near Fort Mandon), Jul–Aug 1811, *Nuttall s.n.* (ISOTYPE: GH; probable ISOTYPE: NY).

2. Machaeranthera tagetina Greene, Pittonia 4:71. 1899. *Aster tagetinus* (Greene) S.F. Blake, Contr. U.S. Natl. Herb. 25:263. 1925. TYPE: U.S.A. ARIZONA. Cochise Co.: near Fort Huachuca, 1891, *Wilcox s.n.* (HOLOTYPE: US).

Dieteria Nutt., Trans. Amer. Philos. Soc., ser. 2, 7:300. 1840. LECTOTYPE, here designated: *Aster canescens* Pursh.

Machaeranthera section *Hesperastrum* A. Gray, Proc. Amer. Acad. Arts 6:539. 1865. *Aster* subgenus *Hesperastrum* (A. Gray) A. Gray, Proc. Amer. Acad. Arts 16:97. 1880. *Aster* section *Hesperastrum* (A. Gray) A. Gray, Syn. Fl. N. Amer. 1(2):174. 1884. TYPE: *Machaeranthera shastensis* A. Gray.

Machaeranthera subgenus *Dieteria* (Nutt.) Greene, Pittonia 3:59. 1896.

Machaeranthera series *Variabiles* Cronquist & D.D. Keck, Brittonia 9:237. 1957, nom. illeg. (ICBN: 24.3).

Herbs taprooted annuals, biennials, or perennials, 10–100 cm tall. **Stems** erect to ascending, much branched when well developed, glabrous to variously pubescent with glandular and/or nonglandular hairs. **Leaves** alternate; entire to irregularly serrate or dentate, moderately to densely pubescent with glandular

and/or nonglandular hairs, apices, including lobes and teeth, spinescent due to indurated apiculae, bristles absent. **Heads** radiate or eradiate. **Involucres** turbinate, campanulate, or hemispheric. **Phyllaries** in 3–12 imbricate to subimbricate series, graduated in length, appressed, spreading, or reflexed, glabrous or variously pubescent with glandular and/or nonglandular hairs; bases indurate, apices herbaceous, margins scarious. **Receptacles** alveolate, convex, naked or scales to 0.3 mm long. **Ray florets** pistillate, fertile (sterile or absent in *D. canescens* var. *shastensis*); corollas white, blue, violet, or purple. **Disc florets** bisexual, fertile, corollas yellow, ± funnelform, tubes and limbs glabrous or glabrate, lobes 0.2–0.7 mm long, glabrous to minutely pubescent. **Cypselae** of ray and disc florets somewhat dimorphic, linear to obovate, glabrous to moderately pubescent; thin walled, smooth or with 4–6 ribs per face, 3–6 mm long, those of ray florets generally flattened, rounded abaxially, of disc florets flattened laterally; pappus white to brown or reddish brown, of ray florets 2/3 to nearly equalling length of disc florets; bristles somewhat barbellate, in 1–3 series, at most somewhat dorsi-ventrally flattened and dissimilar in width near base, bases not to slightly overlapping, mostly 4–8 mm long. $n = 4$.

Although similar to *Machaeranthera* in several ways (see above), the members of *Dieteria* may be distinguished from it by foliage and fruit characters. *Dieteria* has entire to serrate or dentate leaves with thin-walled fruits that are mostly longer than 3 mm, while *Machaeranthera* has leaves that are deeply lobed or dissected and thick-walled fruits that are mostly 3 mm or less long. There is a great deal of morphological variation in *Dieteria*, which has resulted in a large number of species names. The treatment adopted here follows that of Turner (1987) in recognizing three species containing 16 varieties, with 3 varieties in *D. asteroides*, 3 in *D. bigelovii*, and 10 in *D. canescens*. Additional synonymy for *Dieteria* is included in Turner (1987).

KEY TO THE SPECIES OF *DIETERIA*

1. Phyllaries and peduncles both with prominent glandular pubescence.
   2. Leaves covered with stiff glandular hairs _____ **1. Dieteria asteroides** (var. **glandulosa**)
   2. Leaves glabrous to variously pubescent, but not covered with stiff glandular hairs.
      3. Midstem leaves linear-lanceolate to linear or linear-oblanceolate (ovate to obovate in var. *leucanthemifolia*), 1.5–5 mm wide; herbaceous phyllary apices acute to acuminate (1–3 mm long) _____ **3. Dieteria canescens**
      3. Differing from the above in at least one respect; midstem leaves lanceolate to oblanceolate and 5–15 mm wide, *or* herbaceous phyllary apices long-acuminate (2–6 mm long), *or* both _____ **2. Dieteria bigelovii**
1. Phyllaries and peduncles variously pubescent with glandular and/or nonglandular hairs, but rarely with prominent glandular pubescence on both.
   4. Phyllaries usually pubescent throughout, with pubescence on both herbaceous apices and indurate bases, apices acute to long-acuminate, 1–6 mm long; midstem leaves 6–20 mm wide (2–6 mm in var. *lagunensis*) _____ **1. Dieteria asteroides**
   4. Phyllaries only occasionally pubescent throughout, with pubescence mostly con-

fined to herbaceous apices, apices acute to acuminate, 1–3 mm long; mid-stem leaves 1.5–6(–8) mm wide _____ **3. Dieteria canescens**

1. Dieteria asteroides Torr., in Emory Report 142. 1848. *Machaeranthera asteroides* (Torr.) Greene, Pittonia 3:63. 1896. TYPE: U.S.A. NEW MEXICO: "elevated land between the Del Norte and the waters of the Gila," 16 Oct 1847, *Emory s.n.* (HOLOTYPE: NY).

Machaeranthera canescens var. *latifolia* A. Gray, Pl. Wright. 2:75. 1853. *Aster canescens* var. *latifolia* (A. Gray) A. Gray, Syn. Fl. N. Amer. 1(2):206. 1884. TYPE: U.S.A. New Mexico: "Near the copper mines," Sep–Oct 1851, *C. Wright 1152* (LECTOTYPE: GH [designated by Turner 1987]; ISOLECTOTYPES: GH, MO, NY, PH, UC, US).

Aster canescens Pursh var. *tephrodes* A. Gray, Proc. Amer. Acad. Arts 16:99. 1880. *Machaeranthera tephrodes* (A. Gray) Greene, Pittonia 4:24. 1899. *Aster tephrodes* (A. Gray) S.F. Blake, Contr. U.S. Natl. Herb. 25:563. 1925. Typification unclear: In Bot. Calif. 1:322. 1876, Gray mistakenly based the name *Aster incanus* (Lindl.) A. Gray on *Diplopappus incanus* Lindl. for plants occurring in southern California. He subsequently corrected this mistake and proposed the name *Aster canescens* var. *tephrodes* for these plants, noting that they also occurred in Arizona and New Mexico. Although stating that *A. c.* var. *tephrodes* "...was named *A. incanus* in the Botany of California, but....cannot be Lindley's plant," Gray apparently did not select a type specimen for *Aster canescens* var. *tephrodes*. The only material mentioned by Gray in connection with any of these names was collected by "Capt. E.K. Smith" in "Guadalupe Canyon, Sonora," but we have not been able to locate the specimens. Turner (1987) placed *Aster incanus*, *Aster canescens* var. *tephrodes*, *Machaeranthera tephrodes*, and *Aster tephrodes* in synonymy under *Machaeranthera canescens* var. *incana*.

KEY TO THE VARIETIES OF *DIETERIA ASTEROIDES*

1. Stems glabrous to glandular-pubescent; leaves covered with stiff glandular hairs _____ **1b. D. asteroides** var. **glandulosa**
1. Stems pubescent, puberulent, or canescent, glandular pubescence sparse or lacking; leaves puberulent or canescent, stiff glandular hairs sparse or lacking.
   2. Involucres hemispheric; herbaceous phyllary apices long-acuminate, 3 6 mm long; mid-stem leaves 6–20 mm wide, usually clearly serrate or serrulate _____ **1a. D. asteroides** var. **asteroides**
   2. Involucres broadly turbinate (rarely hemispheric); herbaceous phyllary apices acute to acuminate, 1–3 mm long; mid-stem leaves 2–6 mm wide, entire to slightly serrulate _____ **1c. D. asteroides** var. **lagunensis**

1a. Dieteria asteroides var. **asteroides**

1b. Dieteria asteroides var. **glandulosa** (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera asteroides* (Torr.) Greene var. *glandulosa* B.L. Turner, Phytologia 60:77. 1986. TYPE: U.S.A. ARIZONA. Maricopa Co.: U.S. highway 60, 2.6 mi E of Queen Creek tunnel, 4200 ft, 19 Sep 1975, *Pinkava, Keil & Lehto L18904* (HOLOTYPE: LL!; ISOTYPES: ASU, CSU, NY).

1c. Dieteria asteroides var. **lagunensis** (D.D. Keck) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera lagunensis* D.D. Keck, Brittonia 9:238. 1957. *Machaeranthera asteroides* (Torr.) Greene var. *lagunensis* (D.D. Keck) B.L. Turner, Phytologia 60:77. 1986. TYPE: U.S.A. CALIFORNIA. San Diego Co.: 2 mi S of the main recreation area, Laguna Mountains, 5200 ft, 20 Aug 1952, *P.A. Munz & E.K. Balls 17948* (HOLOTYPE: NY; ISOTYPE: RSA).

2. Dieteria bigelovii (A. Gray) D.R. Morgan & R.L. Hartman, comb. **nov.** BASIONYM: *Aster bigelovii* A. Gray, Pacific Railway Survey 4:97. 1857. *Machaeranthera bigelovii* (A. Gray) Greene, Pittonia 3:63. 1896. TYPE: U.S.A. NEW MEXICO. Bernalillo Co.: "arroyos in the Sandia Mountains," 10 Oct 1853, *J.M. Bigelow s.n.* (HOLOTYPE: GH; ISOTYPE: NY).

KEY TO THE VARIETIES OF *DIETERIA BIGELOVII*

1. Involucres hemispheric, 2–3 times broad as tall; phyllaries 90–100, mostly 0.5–1 mm wide at midpoint, herbaceous apices long-acuminate, 2–5 mm long ____ **2c. D. bigelovii** var. **mucronata**

1. Involucres broadly turbinate to hemispheric, 1–2(–3) times broad as tall, phyllaries 25–100, mostly 1–2 mm wide at midpoint, herbaceous apices acute to long acuminate, 2–6 mm long.
   2. Phyllaries 25–50, apices acute to acuminate, 2–4 mm long; ray florets 12–30 ____ **2b. D. bigelovii** var. **commixta**
   2. Phyllaries 50–100, apices long-acuminate, 3–6 mm long; ray florets 30–60 ____ **2a. D. bigelovii** var. **bigelovii**

2a. Dieteria bigelovii var. **bigelovii**

2b. Dieteria bigelovii var. **commixta** (Greene) D.R. Morgan & R.L. Hartman, comb nov. BASIONYM: *Machaeranthera commixta* Greene, Pittonia 4:71. 1899. *Machaeranthera canescens* (Pursh) A. Gray var. *commixta* (Greene) S.L. Welsh, Great Basin Naturalist 43:316. 1983. *Machaeranthera bigelovii* (A. Gray) Greene var. *commixta* (Greene) B.L. Turner, Phytologia 60:77. 1986. TYPE: U.S.A. UTAH. Garfield Co.: Henry Mountains, Bromide Pass, 10,000 ft, 27 Jul 1894, *M.E. Jones 5695y* (HOLOTYPE: US; ISOTYPE: POM).

2c. Dieteria bigelovii var. **mucronata** (Greene) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera mucronata* Greene, Pittonia 4:72. 1899. *Aster adenolepis* S.F. Blake, J. Wash. Acad. Sci. 30:471. 1940, nom. nov., non *Aster mucronatus* Sheldon, 1903. *Machaeranthera bigelovii* (A. Gray) Greene var. *mucronata* (Greene) B.L. Turner, Phytologia 62:238. 1987. TYPE: U.S.A. Arizona. Coconino Co.: Thompson Canyon, 8500 ft, 19 Sep 1894, *M.E. Jones 6065bl* (LECTOTYPE: US [designated by Turner 1987]).

3. Dieteria canescens (Pursh) Nutt., Trans. Amer. Philos. Soc., ser. 2, 7:300. 1840. BASIONYM: *Aster canescens* Pursh, Fl. Amer. Sept. 2:547, 1813. *Machaeranthera canescens* (Pursh) A. Gray, Pl. Wright. 1:89. 1852. TYPE: U.S.A. NORTH DAKOTA: "on the denuded banks of the Missouri" (vicinity of Fort Mandon), 1811, *Nuttall s.n.* (HOLOTYPE: BM; possible ISOTYPE: NDG).

Dieteria viscosa Nutt., Trans. Amer. Philos. Soc., ser. 2, 7:301. 1840. *Aster canescens* Pursh var. *viscosus* (Nutt.) A. Gray, Proc. Amer. Acad. Arts 16:99 1880. *Machaeranthera viscosa* (Nutt.) Greene, Pittonia 4:22. 1899. *Machaeranthera canescens* (Pursh) A. Gray var. *viscosa* (Nutt.) Piper, Contr. U.S. Natl. Herb. 11:576. 1905. TYPE: U.S.A. NEBRASKA. Scotts Bluff Co.: "near Scott's Bluff, on the Platte," 1834, *Nuttall s.n.* (HOLOTYPE: BM).

Dieteria divaricata Nutt., Trans. Amer. Philos. Soc., ser. 2, 7:301. 1840. *Machaeranthera divaricata* (Nutt.) Greene, Pittonia 4:23. 1899. TYPE: U.S.A.: "denudated plains of the Rocky Mountains and Oregon, common," 1834, *Nuttall s.n.* (HOLOTYPE: GH).

Dieteria pulverulenta Nutt., Trans. Amer. Philos. Soc, ser. 2, 7:300. 1840. *Machaeranthera*

pulverulenta (Nutt.) Greene, Pittonia 4:23. 1899. TYPE: U.S.A.: "arid plains towards the sources of the Platte," 1834, *Nuttall s.n.* (HOLOTYPE: PH).

Machaeranthera laetevirens Greene, Pittonia 3:61. 1896. *Aster leiodes* Blake, Contr. U.S. Natl. Herb. 25:563. 1925, nom. nov., non Aster *laetevirens* Greene (1900). TYPE: U.S.A. NEVADA. Elko Co.: Clover Mountains, 26 Jul 1894, *E.L. Greene s.n.* (HOLOTYPE: NDG; ISOTYPE: NDG).

Machaeranthera latifolia A. Nelson, Proc. Biol. Soc. Wash. 20:38. 1907. *Machaeranthera canescens* (Pursh) A. Gray var. *latifolia* (A. Nelson) S.L. Welsh, Great Basin Naturalist Mem. 9:213. 1987. *Machaeranthera canescens* (Pursh) A. Gray var. *monticola* Dorn, Vascular Pl. Wyo. 295. 1988. TYPE: U S.A. UTAH. Salt Lake Co.: Big Cottonwood Canyon, 8950 ft, 9 Aug 1933, *A. O. Garrett 1933* (HOLOTYPE: RM!; ISOTYPES: GH, LL!, US).

KEY TO THE VARIETIES OF *DIETERIA CANESCENS*

1. Phyllaries spreading to reflexed, rarely appressed.
   2. Involucres mostly (9–)10–16 mm tall.
      3. Suffruticose perennials; involucres (10–)12 -16 mm tall; phyllary apices densely glandular _____ **3f. D. canescens** var. **ziegleri**
      3. Biennials or short-lived perennials; involucres (9)10–15 mm tall; phyllary apices densely appressed-pubescent, glands if present obscured by appressed pubescence _____ **3j. D. canescens** var. **nebraskana**
   2. Involucres mostly 6–10(–12) mm tall.
      4. Stems canescent; glandular pubescence sparse or lacking.
         5. Plants usually with a single stiffly erect stem; branches stiff and straight, widely divaricate _____ **3b. D. canescens** var. **incana**
         5. Plants with a single stem or with multiple ascending stems; branches flexible and curved, loosely spreading or (usually) ascending but not widely divaricate.
            6. Ray florets sterile or absent; phyllaries 3–5(–7) seriate _____ **3e. D. canescens** var. **shastensis**
            6. Ray florets pistillate and fertile; phyllaries 5–10 seriate _____ **3a. D. canescens** var. **canescens**
      4. Stems evidently glandular, frequently also puberulent or canescent, occasionally glabrous.
         7. Stems canescent, glands usually sessile or subsessile; most heads sessile or with peduncles shorter than involucre height _____ **3d. D. canescens** var. **sessiliflora**
         7. Stems with prominent stipitate glands, also occasionally puberulent or canescent; most peduncles longer than involucre height.
            8. Midstem and upper leaves ovate, oblong or obovate, 1.5–4 times longer than wide _____ **3c. D. canescens** var. **leucanthemifolia**
            8. Midstem and upper leaves linear-lanceolate to linear, more than 4 times longer than wide _____ **3h. D. canescens** var. **aristata**
1. Phyllaries appressed or occasionally spreading, rarely reflexed.
   9. Ray florets sterile or absent _____ **3e. D. canescens** var. **shastensis**
   9. Ray florets pistillate and fertile.
      10. Phyllaries densely appressed pubescent, glandular pubescence lacking or sparse and obscured by appressed pubescence _____ **3g. D. canescens** var. **ambigua**
      10. Phyllaries glabrous to glandular-pubescent, rarely appressed-pubescent or canescent.
         11. Stems with prominent stipitate glands, occasionally also canescent, rarely glabrous _____ **3h D. canescens** var. **aristata**

11. Stems glabrous to puberulent or canescent, stipitate glands sparse or lacking _____ **3i D. canescens** var. **glabra**

(i) Dieteria canescens subsp. **canescens**

3a. Dieteria canescens var. **canescens**

3b. Dieteria canescens var. **incana** (Lindl.) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Diplopappus incanus* Lindl., Bot. Reg. 20:t. 1693, 1834. *Dieteria incana* (Lindl.) Torr. & A. Gray, Fl. N. Amer. 2:100. 1841. *Machaeranthera canescens* (Pursh) A. Gray var. *incana* (Lindl.) A. Gray, Bot. Wilkes Exp. Phan. 17(2):340. 1874. *Machaeranthera incana* (Lindl.) Greene, Pittonia 3:62. 1896. TYPE: U.S.A. OREGON: "Columbia River," described from seeds grown in London, 1830, *Douglas s.n.* (HOLOTYPE: BM; ISOTYPE: GH; ISOTYPE, microfiche: G-DC).

3c. Dieteria canescens var. **leucanthemifolia** (Greene) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Aster leucanthemifolius* Greene, Erythea 3:119. 1895. *Machaeranthera leucanthemifolia* (Greene) Greene, Pittonia 3:61. 1896. *Machaeranthera canescens* (Pursh) A. Gray var. *leucanthemifolia* (Greene) S.L. Welsh, Great Basin Naturalist 43:316. 1983. TYPE: U.S.A. NEVADA. Esmeralda Co.: near Candelaria, 6000 ft, Jun 1886, *W.H. Shockley 268* (HOLOTYPE: CAS; ISOTYPES: DS, US).

3d. Dieteria canescens var. **sessiliflora** (Nutt.) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Dieteria sessiliflora* Nutt., Trans. Amer. Philos. Soc., ser. 2, 7:301. 1840. *Machaeranthera sessiliflora* (Nutt.) Greene, Pittonia 3:60. 1896. *Machaeranthera canescens* (Pursh) A. Gray var. *sessiliflora* (Nutt.) B.L. Turner, Phytologia 60:78. 1986. TYPE: U.S.A. IDAHO(?): "Denudated plains of the Rocky Mountains and Oregon," 1836, *Nuttall s.n.* (HOLOTYPE: BM).

3e. Dieteria canescens var. **shastensis** (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera shastensis* A. Gray, Proc. Amer. Acad. Arts 6:539. 1866. *Aster shastensis* (A. Gray) A. Gray, Bot. Calif. 1:322. 1876. *Machaeranthera canescens* (Pursh) A. Gray var. *shastensis* (A. Gray) B.L. Turner, Phytologia 60:79. 1986. TYPE: U.S.A. CALIFORNIA. Siskiyou Co.: Mt. Shasta, 9000 ft, 1860–62, *W.H. Brewer 1385* (HOLOTYPE: GH; ISOTYPE: US).

3f. Dieteria canescens var. **ziegleri** (Munz) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera canescens* (Pursh) A. Gray subsp. *ziegleri* Munz, Aliso 7:65. 1969. *Machaeranthera canescens* (Pursh) A. Gray var. *ziegleri* (Munz) B.L. Turner, Phytologia 60:79. 1986. TYPE: U.S.A. CALIFORNIA. Riverside Co.: N side of Santa Rosa Mountain, 6500–7500 ft, 30 Sep 1968, *L.B. Ziegler s.n.* (HOLOTYPE: RSA; ISOTYPE: CAS).

(ii) Dieteria canescens subsp. **glabra** (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov. *Machaeranthera canescens* (Pursh) A. Gray var. *glabra* A. Gray, Pl. Wright. 1:89. 1852. *Machaeranthera canescens* (Pursh) A. Gray subsp. *glabra* (A. Gray) B.L. Turner, Phytologia 62:239. 1987.

3g. Dieteria canescens var. **ambigua** (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera canescens* (Pursh) A. Gray var. *ambigua* B.L. Turner, Phytologia 60:77. 1986. TYPE: U.S.A. ARIZONA. Coconino Co.: Flagstaff,

28 Aug 1922, *H. Hanson A7* (HOLOTYPE: TEX!; ISOTYPES: ARIZ, F, MO, NEB, NY, OSU, PHIL, RM!, TEX!).

3h. Dieteria canescens var. **aristata** (Eastwood) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Aster canescens* Pursh var. *aristatus* Eastwood, Proc. Calif. Acad. Sci., ser. 2, 6:296. 1896. *Machaeranthera canescens* (Pursh) A. Gray var. *aristata* (Eastwood) B.L. Turner, Phytologia 60:78. 1986. TYPE: U.S.A. UTAH. San Juan Co.: Willow Creek, 14 Jul 1895, *A. Eastwood 45* (HOLOTYPE: CAS).

Machaeranthera rigida Greene, Pittonia 4:25. 1899. TYPE: U.S.A. ARIZONA. Navajo Co.: "Kearn's Canyon," 20 Aug 1897, *Zuck 41* (HOLOTYPE: NDG).

3i. Dieteria canescens var. **glabra** (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera canescens* (Pursh) A. Gray var. *glabra* A. Gray, Pl. Wright. 1:89. 1852. *Aster canescens* Pursh var. *viridis* A. Gray, Proc. Amer. Acad. Arts 16:99. 1880. TYPE: U.S.A. NEW MEXICO. Dona Ana Co.: Rio Grande Valley at Presidio San Elizario on sand-bars, 22 Sep 1849, *C. Wright 262 (field no. 1258)* (LECTOTYPE: GH [designated by Turner 1987]; ISOLECTOTYPES: GH, MO, UC).

Machaeranthera linearis Greene, Bull. Torrey Bot. Club 24:511. 1897, non *Machaeranthera linearis* Rydb. 1900. *Aster linearis* (Greene) Cory, Rhodora 38:407. 1936. TYPE: U.S.A. NEW MEXICO. Dona Ana Co.: Mesilla Valley, 3900 ft, 6 Sep 1897, *E.O. Wooton 444* (LECTOTYPE: NDG [designated by Turner 1987]; ISOLECTOTYPES: DS, GH, MO, NY, RM!, UC, US).

3j. Dieteria canescens var. **nebraskana** (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera canescens* (Pursh) A. Gray var. *nebraskana* B.L. Turner, Phytologia 60:78. 1986. TYPE: U.S.A. NEBRASKA. Sheridan Co.: 2 mi E Ellsworth, sandhill prairie on dry, loose sand, 27 Aug 1968, *S. Stephens 28307* (HOLOTYPE: NY; ISOTYPES: ARIZ, DS, GH).

Xanthisma DC., Prodr. 5:94. 1836. TYPE: *Xanthisma texanum* DC.

Eriocarpum Nutt., Trans. Amer. Philos. Soc., ser. 2, 7:320. 1840. TYPE: *Eriocarpum grindelioides* Nutt.

Sideranthus Nutt. ex C. Nees in M. Wied-Neuwied, Reise Nord-America 2:440. 1841. TYPE: *Amellus spinulosus* Pursh.

Centauridium Torr. & A. Gray, Fl. N. Amer. 2:246. 1842. TYPE: *Centauridium drummondii* Torr. & A. Gray.

Dieteria subgenus *Sideranthus* (Nutt. ex Nees) Nutt., Trans. Amer. Philos. Soc., ser. 2, 7:301. 1840.

Machaeranthera subgenus *Sideranthus* (Nutt. ex Nees) R.L. Hartman, Phytologia 68:456. 1990.

There has been disagreement on the dates of publication for *Eriocarpum* and *Sideranthus*. For example, Farr, Leussink, and Stafleu (1979) give them as Oct–Dec 1840 and 1840, respectively. According to Greene (1895), Nuttall's treatment (p.320) of *Eriocarpum* appeared in 1840 (for pp. 283–356). Subsequently, *Sideranthus* was published by C. Nees in 1841 (Stafleu & Cowan 1981, p. 707).

Herbs taprooted annuals, biennials, or perennials, if perennial usually with a much-branched, woody caudex or rhizomatous (forming loose colonies in *X. rhizomatum*), 3–100 cm tall. **Stems** erect or spreading or sprawling, often much branched, glabrous or moderately to densely pubescent with glandular or nonglandular hairs. **Leaves** alternate; entire to serrate, dentate, pinnatifid, or

bipinnatifid, moderately to densely pubescent with glandular or nonglandular hairs, apices, including lobes and teeth, apiculate to bristle tipped, bristles if present 1–4 mm long. **Heads** radiate or eradiate. **Involucres** turbinate, campanulate, or hemispheric. **Phyllaries** in 2–8 imbricate series, graduated in length, appressed, spreading, or reflexed, glabrous or moderately to densely pubescent with glandular or nonglandular hairs; bases indurate, apices herbaceous or achlorophyllous, stiff, leathery, or margins scarious. **Receptacles** alveolate, flat to convex, scales laciniate, 0.3–3 mm long, often forming a reticulum. **Ray florets** pistillate, fertile (absent in *X. grindelioides, X. johnstonii, X. restiforme*); corollas white, pink, red-purple, purple, or yellow. **Disc florets** bisexual, fertile, corollas yellow, ± funnelform, tubes and limbs glabrous to somewhat pubescent, lobes 0.4–0.9 mm long, glabrous to pubescent. **Cypselae** of ray and disc florets distinctly dimorphic, elliptic to obovate, oblong, or obscurely cordate, sparsely to densely pubescent; thin to thick walled, with 3–9 nerves or ribs per face, (1–)1.5–3.5 mm long, those of ray florets, if present, ± 3 sided, rounded abaxially, of disc florets compressed laterally; pappus usually whitish to brown or reddish brown, of ray florets 1/2 to nearly equaling length of disc florets; bristles coarsely barbellate, in 2–4 series, dorsi-ventrally flattened and dissimilar in width near base, bases overlapping, mostly 3.5–8 mm long. $n = 2, 3, 4, 8$.

As defined here, the genus *Xanthisma* consists of the former *Machaeranthera* sections *Blepharodon*, *Sideranthus*, *Havardii*, and *Stenoloba*, plus the unispecific genus *Xanthisma*, which because of the rule of priority becomes the name of the genus. The grouping of *Xanthisma* and these four sections of *Machaeranthera* (sensu Morgan 1993) was well supported by nrDNA evidence (Morgan 2003), and, except for *Arida blepharophylla* (see discussion below), cpDNA evidence did not support any conflicting relationships (Fig. 1). Although *Xanthisma* includes species with both cyanic (blue, purple, pink, or white) and yellow rays, several other morphological characteristics are shared by its members, including short, turbinate, thick-walled fruits that are densely pubescent, receptacular scales, leaves with marginal spines, and chromosome numbers based on $x = 4$. Many of these species have in fact been grouped together at the generic or sectional level by authors such as Greene (1894) and Hall (1928).

The following key is based largely on data from Hartman (1976, 1990) and Semple (1974).

KEY TO THE SPECIES OF *XANTHISMA*

1. Inner phyllaries, at least, with a basal "stalk," abruptly enlarged into an ovate to orbicular or elliptic blade, mostly 2–5 mm wide and glabrous; apices abruptly acuminate to obtuse, or broadly rounded, not bristle-tipped _____ **1. Xanthisma texanum**
1. Inner phyllaries, as with all, not markedly expanded above, linear to broadly oblong or lanceolate, mostly 1 -2 mm wide; apices narrowly obtuse to long-attenuate, usually bristle-tipped.

2. Ray florets absent.
   3. Primary cauline leaves mostly 1–6 cm long, if shorter or absent then plants with several single headed stems arising from a cushion of basal leaves; stems lacking axillary rosettes; NW New Mexico and N Arizona to S Canada _____ **5. Xanthisma grindelioides**
   3. Primary cauline leaves 0.2–1 cm long, basal leaves not persisting on mature plants; stems covered by axillary rosettes of tiny leaves; Coahuila and Nuevo León, Mexico.
      4. Main stem leaves on new growth oblong to narrowly lanceolate; stems canescent to slightly tomentose, the pubescence increasing the stem diameter but slightly; plants much branched and bushy with flexible stems _____ **8. Xanthisma johnstonii**
      4. Main stem leaves deltoid to narrowly triangular; stems densely woolly-tomentose, the pubescence increasing the stem diameter 2 to 3 times; plants divergently but sparingly branched with rigid, rope like stems _____ **9. Xanthisma restiforme**
2. Ray florets present.
   5. Ray floret corollas white, pink, purple, or lavender.
      6. Plants dwarf, arising from a cluster of basal leaves; stems leafy, up to 12 cm tall, few to several, each 1 headed; montane to alpine, Colorado and S Wyoming _____ **3. Xanthisma coloradoense**
      6. Plants usually robust, basal leaves usually not persisting on the mature plant; stems not always leafy, mostly 15 to 40 cm tall, often branched, each with 1 to 10 or more heads; central NM, W Texas; N half of Mexico.
         7. Plants biennial or short-lived perennial herbs from a normal taproot; ray flowers pink, purple, or lavender (often fading on old specimens); peduncles moderately to densely glandular-stipitate, often with long flexuous hairs intermixed; phyllaries usually herbaceous in upper half, long-attenuate, reflexed or widely spreading; highlands, central Mexico to S edge of the Chihuanuan Desert _____ **6. Xanthisma gymnocephalum**
         7. Plants perennial from a woody, branched caudex, often with a thickened taproot; ray flowers white (rarely purple in *X. gypsophilum*), often with pink or purple streaks on the underside; peduncles villous, hispid, or glandular-stipitate; phyllaries not herbaceous above but with a green or purple strip or patch in the upper half, the tips acute to broadly acuminate, appressed to squarrose; Chihuahuan Desert and vicinity and mountains of W Texas and S New Mexico.
            8. Peduncles and leaves moderately to densely villous; leaves crowded on the lower half to two-thirds of the stem, not greatly reduced in size above (except for 1 or 2 reduced bracts); flowering stems usually unbranched, bearing only one head _____ **4. Xanthisma crutchfieldii**
            8. Peduncles and leaves glandular-stipitate and/or hispid to hispidulose; leaves evenly distributed along the stem usually for well over two-thirds its length, often markedly though gradually reduced in size above; flowering stems often at least sparingly branched with 1 to 10 or more heads.
               9. Peduncles stipitate-glandular; leaves serrate, often coarsely so with 5 to 14 pairs of teeth; SE New Mexico, W Texas; N Mexico _____ **7. Xanthisma gypsophilum**
               9. Peduncles hispid or hispidulose; leaves usually finely or obscurely

serrate or serrulate, usually with 12 to 25 pairs of teeth; south-central New Mexico to W Texas _____ **2. Xanthisma blephariphyllum**

5. Ray floret corollas yellow.
   10. Plants growing in loose colonies with stems arising from 3 to 10 or more elongate (2–15 cm or more long), branched rhizomes, 1.5–6 mm in diameter, arising from a woody rootstock; leaves without glands _____ **10. Xanthisma rhizomatum**
   10. Plants from a taproot or woody caudex, not rhizomatous; leaves often glandular.
      11. Cypselae of disc florets broadly obovate to obscurely and narrowly cordate, the thick, bony walls with 10–12 prominent ribs, densely pubescent, margins thickened; pappus mostly of subulate, markedly dorsiventrally flattened bristles 2–3 mm long; plants annual; leaves deeply pinnatifid or bipinnatifid; SW Chihuahua, Mexico _____ **15. Xanthisma stenolobum**
      11. Cypselae of disc florets oblong to narrowly obovate, walls usually thin, flexible, smooth or with 6–16 obscure ribs, glabrous to moderately pubescent, margins not thickened; pappus of filiform, only slightly flattened bristles 3.5–7 mm long; plants annual to perennial; leaves entire to bipinnatifid; occurring elsewhere.
         12. Plants taprooted, annual; phyllaries obtuse to broadly acute, not bristle tipped; leaves serrate or dentate, the teeth blunt or terminating in a stiff callosity, not bristle tipped; cypselae oblong or narrowly elliptic with 12–14 barely discernible nerves, sparsely pubescent; lowlands of SE New Mexico and W Texas _____ **17. Xanthisma viscidum**
         12. Plants perennial with much-branched caudices, if taprooted annuals then phyllaries with narrowly acute to acuminate and prominently bristle tipped apices; leaves various, if serrate or dentate, the teeth bristle tipped; cypselae elliptic to narrowly obovate with 6–16 weak ribs, glabrous to moderately pubescent; Canada to S U.S.; Mexico.
            13. Plants annual with herbaceous stems and bases; involucres eglandular.
               14. Leaves with entire margins, not bristle lined, or lower cauline and basal ones tridentate or sometimes pinnatifid; phyllaries tipped by bristles 0.1–0.3 mm long; NE Baja California, Mexico _____ **16. Xanthisma wigginsii**
               14. Leaves uniformly spinulose toothed or lobed, bristles usually 1.5 3 mm long; phyllaries (except innermost series) tipped by bristles usually 0.6–1.5 mm long; occurring elsewhere _____ **12. Xanthisma gracile**
            13. Plants perennial, stems with woody bases; involucres glandular.
               15. Bracts of peduncles imbricate and grading into phyllaries; stems nearly leafless above base _____ **13. Xanthisma junceum**
               15. Bracts of peduncles few and not grading into phyllaries; stems leafy or leaves reduced near inflorescence.
                  16. Phyllaries strongly squarrose in upper half; leaves thickish, usually oblanceolate to spatulate with

bluntly dentate to subentire margins; S Baja California Sur, Mexico _____ **11. Xanthisma arenarium**

16. Phyllaries with appressed to spreading apices; leaves thin, usually oblong to lanceolate with prominent teeth or lobes; SW Canada, W U.S.A.; N half of Mexico _____ **14. Xanthisma spinulosum**

Xanthisma DC. section **Xanthisma**

Herbs taprooted annuals, rarely biennials, 20–90 cm tall, taproot sometimes thickened. **Leaves** entire on upper stem, serrate below, pinnatifid to bipinnatifid near base, teeth or lobes usually with apiculate callosities, not bristle tipped. **Heads** radiate. **Involucres** turbinate to hemispheric or campanulate. **Phyllaries** in 3–4 graduated series, the lower portion stalk-like, stiff, stramineous, enlarged above into an ovate to orbicular or depressed elliptic blade with a glabrous, green patch; apices acuminate or obtuse and cuspidate or broadly rounded, not bristle tipped. **Receptacles** alveolate, scales 0.2–2 mm long, mostly distinct. **Ray floret** corollas yellow. **Cypselae** distinctly dimorphic, 1.5–2.2 mm long, narrowly obovoid to oblong, walls thick with 8–16, often obscure ribs, sparsely pubescent; ray cypselae 3 sided; disc cypselae compressed laterally, generally 4 sided. **Pappus** similar in ray and disc florets, tawny; bristles 3–7 mm long, linear, dorsiventrally flattened basally, in 2 series. $n = 4$.

1. Xanthisma texanum DC., Prodr. 5:95. 1836. TYPE: U.S.A. TEXAS. Bexar Co.: woods near Medina, May 1828. *J.L. Berlandier 2039* (LECTOTYPE: IDC microfiche 800. 787.I.7, G-DC! [designated by Semple 1974]; ISOLECTOTYPES: G-DC, GH, NY, US).

Xanthisma texanum DC. var. *berlandieri* A. Gray, Pl. Wright. 1:98. 1852. *Xanthisma berlandieri* (A. Gray) J.K. Small, Fl. S.E. U.S. 1184. 1903. TYPE: U.S.A. SOUTHERN TEXAS: *J.L. Berlandier s.n.*; on the Nueces, *A. Trécul s.n.* (SYNTYPES: GH).

KEY TO THE INFRASPECIFIC TAXA OF *XANTHISMA TEXANUM*

1. Blades of phyllaries somewhat expanded above the proximal stalk, mostly orbicular to depressed elliptic: dimensions above the widest part 1–2 mm long, 1.5–3.5 mm wide _____ **1a. X. texanum** subsp. **texanum**

2. Phyllary apices rounded with little or no flare 1 mm from the apex _____ **1b. X. texanum** subsp. **texanum** var. **texanum**

2. Phyllary apices obtusely cuspitate, flared distally, the ovate portion 1.5–2 mm long, 2–3 mm wide above the widest portion _____ **1c. X. texanum** subsp. **texanum** var. **orientale**

1. Blades of phyllaries abruptly expanded above proximal stalk, mostly ovate: dimensions above the widest part 3.5–8 mm long, 2.5–5 mm wide _____ **1d. X. texanum** subsp. **drummondii**

1a. Xanthisma texanum DC. subsp. **texanum**

1b. Xanthisma texanum DC. subsp. **texanum** var. **texanum**

1c. Xanthisma texanum DC. subsp. **texanum** var. **orientale** Semple, Rhodora 76:14.

1974. TYPE: U.S.A. TEXAS. Hidalgo Co.: 13.5 mi N of Edinburg on U.S. hwy 183, 8 Jul 1970, *W. Lewis 7642* (HOLOTYPE: MO).

1d. Xanthisma texanum DC. subsp. **drummondii** (Torr. & A. Gray) Semple, Rhodora 76:16. 1974. BASIONYM: *Centauridium drummondii* Torr. & A. Gray, Fl. N. Amer. 2:246. 1842. *Xanthisma texanum* DC. var. *drummondii* (Torr. & A. Gray) A. Gray, Pl. Wright. 1:98. 1852. *Xanthisma drummondii* (Torr. & A. Gray) Hooker f., Curtis' Bot. Mag. 33:t. 6275. 1877. TYPE: U.S.A. TEXAS: exact locality unknown, Nov 1835, *T. Drummond 227* (LECTOTYPE: GH [designated by Semple 1974]; ISOLECTOTYPES: GH!, NY!).

Xanthisma texanum DC. subsp. *texanum* var. *orientale* Semple forma *rubrum* Semple, Rhodora 76:15. 1974. TYPE: U.S.A. TEXAS. San Patricio Co.: 0.5 mi E of Ingleside on Texas hwy 361, 13 Jun 1971, *J.C. Semple 602* (HOLOTYPE: MO).

This polymorphic species has always been maintained distinct from other genera in the Tribe; in part due to the unique involucre. The relationship to members of *Machaeranthers* sensu lato was never seriously considered until data from DNA became available. According to Semple (1974) the following combination of features characterized the species: "heterocarpic fruit with a pappus of bristly scales only, fruit pubescence of long white ascending hairs, receptacle slightly convex with a persistent reticulate network of subulate scales." Interestingly, all of these characters are found in at least some of the taxa of this newly expanded genus.

Semple (1974) recognized two forms of variety *orientale*, the typical one having whitish lateral margins on the bracts and forma *rubrum* in which the lateral margins were red. Forma *rubrum* is said to be rare but is found mixed with the typical form throughout the range of var. *orientale*.

Xanthisma section **Blepharodon** (DC.) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Haplopappus* section *Blepharodon* DC., Prodr. 5:346. 1836, "*Aplopappus*," non *Blepharodon* Decne. in DC., 1844 [Asclepiadaceae].

Machaeranthera section *Blepharodon* (DC.) R.L. Hartman, Phytologia 68:443. 1990. TYPE: *Haplopappus gymnocephalus* DC., "*Aplopappus*" (lectotype designated by Hall 1928, from among the four species included).

Eriocarpum Nutt., Trans. Amer. Philos. Soc., ser. 2, 7:320. 1840. *Haplopappus* section *Eriocarpaea* Benth. & J.D. Hook., Gen. Pl. 2:254. 1873, based on *Eriocarpum* Nutt., Trans. Amer. Philos. Soc., ser. 2, 7:320. 1840. TYPE: *Eriocarpum grindelioides* Nutt.

Machaeranthera series *Originales* Cronquist & D.D. Keck, Brittonia 9:237. 1957, nom. illeg. (ICBN: 24.3).

Herbs taprooted annuals, biennials, or perennials, 3–50 cm tall, often with a much branched caudex or in loose colonies with stems arising from 3 to 10 or more elongate, branched rhizomes, 1.5–6 mm in diameter, from a woody rootstock. **Leaves** serrate or dentate, entire or rarely pinnatifid in a few species, teeth or lobes usually bristle tipped. **Heads** radiate or eradiate. **Involucres** depressed hemispheric to campanulate. **Phyllaries** in 3–6 graduated series, linear to lanceolate, the lower portion thickened, stramineous, the upper fourth to half her-

baceous or with a green or purple tinged strip or patch, stipitate glandular to canescent, appressed to reflexed; apices obtuse to long attenuate and usually bristly tipped. **Receptacles** alveolate, scales often present, 0.3–1.5 mm long, distinct or forming a reticulum. **Ray floret** corollas white, pink, purple, or lavender when present (yellow in *Xanthisma rhizomatum*). **Cypselae** distinctly dimorphic, (1–)1.5–3.5 mm long, narrowly obovoid to oblong, the walls thick with 6–18, often prominent ribs, often densely pubescent; ray cypselae obscurely 3 sided; disc cypselae compressed laterally. **Pappus** white to tawny; bristles 3.5–8 mm long, dorsiventrally flattened basally, in 2–4 graduated series, those of the ray florets often much reduced in length. $n = 4, 8$.

2. Xanthisma blephariphyllum (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Haplopappus blephariphyllus* A. Gray, Pl. Wright. 1:97. 1852, "*Aplopappus*." *Eriocarpum blephariphyllum* (A. Gray) Greene, Erythea 3:14. 1895. *Machaeranthera blephariphylla* (A. Gray) Shinners, Field & Lab. 18:38. 1950. TYPE: U.S.A. Probably TEXAS: plains at the eastern base of the Guadalupe Mountains, 18 Oct 1849, *C. Wright 288* (HOLOTYPE: GH!; ISOTYPE: NY!).

Eriocarpum serratum Greene, Bull. Torrey Bot. Club 25:119, pl. 331, fig. 3, 4. 1898. *Sideranthus serratus* (Greene) Standley, Contr. U.S. Natl. Herb. 13:222. 1910. TYPE: U.S.A. NEW MEXICO. Lincoln Co.: White Mountains, S fork of Tularosa Creek E of the Mescalero Agency, 6800 ft, 30 Jul 1897, *E.O. Wooton 251* (HOLOTYPE: NDG!; ISOTYPES: B, K, MO!, NY!, RM!, UC!).

Machaeranthera correllii Shinners, Field & Lab. 17:55. 1949. TYPE: U.S.A. TEXAS. Culberson Co.: Guadalupe Mountains, Pine Springs Canyon, 5700 ft, 15 Aug 1946, *L. Shinners 9059* (HOLOTYPE: SMU!).

3. Xanthisma coloradoense (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Aster coloradoensis* A. Gray, Proc. Amer. Acad. Arts 11:76. 1876. *Eriocarpum coloradoense* (A. Gray) Greene, Erythea 2:110. 1894, "*coloradense*." *Xylorhiza coloradoensis* (A. Gray) Rydb., Bull. Torrey Bot. Club 32:124. 1905, "*Xylorrhiza coloradensis*." *Machaeranthera coloradoensis* (A. Gray) Osterhout, Torreya 27:64. 1927, "*coloradensis*," *Haplopappus coloradoensis* (A. Gray) R.L. Hartman ex R. D. Dorn, Vasc. Pl. Wyoming 295. 1988. TYPE: U.S.A. COLORADO: South Park near Hamilton, 4 Aug 1875, *E.L. Greene 679* (LECTOTYPE, here designated from among syntypes: GH!).

Xylorhiza brandegei Rydb., Bull. Torrey Bot. Club 32:124. 1905, "*Xylorrhiza*." *Machaeranthera coloradoensis* (A. Gray) Osterhout var. *brandegei* (Rydb.) T.J. Watson ex R.L. Hartman, Phytologia 68:444. 1990. TYPE: U.S.A. COLORADO: San Juan Pass, 1875, *T.S. Brandegee 1165* (HOLOTYPE: GH!; ISOTYPES: NY!, UC!).

4. Xanthisma crutchfieldii (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera crutchfieldii* B.L. Turner, Phytologia 26:116. 1973. TYPE: MEXICO. NUEVO LEÓN: bare gypsum rock outcrop on south slopes, 17 mi E of San Roberto Junction, then 2 mi S, 24 Oct 1970, *B.L. Turner & J. Crutchfield 6324* (HOLOTYPE: TEX!; ISOTYPE: MEXU!).

5. Xanthisma grindelioides (Nutt.) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Eriocarpum grindelioides* Nutt., Trans. Amer. Philos. Soc., ser. 2, 7:321. 1840. *Haplopappus nuttallii* Torr. & A. Gray, Fl. N. Amer. 2:242. 1842, "*Aplopappus*,"

nom. nov., non *Haplopappus grindelioides* DC., Prodr. 5:348. 1836, "*Aplopappus*." *Aster nuttallii* (Torr. & A. Gray) O. Kuntze, Revis. Gen. Pl. 1:318. 1891, non Torr. & A. Gray, 1842. *Sideranthus grindelioides* (Nutt.) Britton in Rydb., Bull. Torrey Bot. Club 27:620. 1900. *Machaeranthera grindelioides* (Nutt.) Shinners, Field & Lab. 18:40. 1950. TYPE: U.S.A. (WYOMING): on shelving rocks in the Rocky Mountain range, Oregon, s.d., *T. Nuttall s.n.* (HOLOTYPE: PH!; ISOTYPE: BM).

KEY TO THE VARIETIES OF *XANTHISMA GRINDELIOIDES*

1. Plants tufted, mostly 10–35 cm tall; leaves evenly distributed along the length of the stem, the margins often ciliate or spinulose-toothed but the bristles usually less than 1.5 mm long; peduncles less than 2 cm long, often leafy to the base of the capitulum; heads solitary or 2 to 5 per stem _____ **5a. X. grindelioides** var. **grindelioides**
1. Plants densely cespitose, mostly less than 8 cm tall; leaves mostly crowded at the base of the plant, the margins lined with conspicuous, white bristles up to 4 mm long; peduncles 1–4 cm long, naked or with an occasional greatly-reduced leaf; heads mostly solitary _____ **5b. X. grindelioides** var. **depressum**

5a. Xanthisma grindelioides var. **grindeloides**

5b. Xanthisma grindelioides var. **depressum** (Maguire) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Haplopappus nuttallii* Torr. & A. Gray var. *depressus* Maguire, Amer. Midl. Naturalist 37:144. 1947. *Machaeranthera grindeloides* (Nut) Shinners var. *depressa* (Maguire) Cronquist & D.D. Keck, Brittonia 9:237. 1957. TYPE: U.S.A. UTAH. Millard Co.: Warm Point, in shallow gravelly and sandy soil, 5 mi SW of Desert Range Experiment Station Headquarters, 18 Jun 1941, *B. Maguire 20859* (HOLOTYPE: NY!; ISOTYPES: GH!, UC!).

6. Xanthisma gymnocephalum (DC.) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Haplopappus gymnocephalus* DC., Prodr. 5:346. 1836, "*Aplopappus*." *Aster gymnocephalus* (DC.) A. Gray, Proc. Amer. Acad. Arts 15:32. 1879, non (F. Ruprecht) B. Fedtschenko, 1915. *Eriocarpum gymnocephalum* (DC.) Greene, Erythea 2:109. 1894. *Machaeranthera gymnocephala* (DC.) Shinners, Field & Lab. 18:40. 1950. TYPE: MEXICO: "Environs de Mexico," 20 Jul 1827, *J.L. Berlandier 588* (LECTOTYPE, here designated: IDC microfiche 800. 867.III.6, G-DC!).

Machaeranthera setigera Nees, Linnaea 19:722. 1847. TYPE: "In terris Mexicanis," *De Berghes s.n.* (location of type unknown).

Haplopappus phyllocephalus DC. subsp. *primitivus* H.M. Hall, Publ. Carnegie Inst. Wash. 389:56, fig. 6. 1928. TYPE: MEXICO. MEXICO. Calcareous bluffs, Flor de María, 31 Jul 1890, *C.G. Pringle 3179* (HOLOTYPE: UC!; ISOTYPES: GH!, NY!, PH!, SMU!, UC!).

7. Xanthisma gypsophilum (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera gypsophila* B.L. Turner, Phytologia 26:117. 1973. TYPE: MEXICO. COAHUILA: 14 mi S of Cuatro Ciénegas, then W 1.8 mi to actively blowing dunes of gypsum, 11 Apr 1970, *B.L. Turner 6052* (HOLOTYPE: TEX!; ISOTYPES: MEXU!, MICH!).

8. Xanthisma johnstonii (S.F. Blake) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Haplopappus johnstonii* S.F. Blake, Proc. Biol. Soc. Wash. 54:18. 1941, "*Aplopappus*." *Machaeranthera johnstonii* (S.F. Blake) B.L. Turner, Amer. J. Bot. 60:837. 1973. TYPE: MEXICO. COAHUILA: in dry heavy alkaline soil, 1 mi S of Hermanas, 22–24 Aug 1938, *I.M. Johnston 7066* (HOLOTYPE: GH!; ISOTYPE: US!).

9. Xanthisma restiforme (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera restiformis* B.L. Turner, Amer. J. Bot. 60:836, figs. 1–5. 1973. TYPE: MEXICO. Coahuila: in gypsum soil 2.4 mi SW of Cuatro Ciénegas, 11 Apr 1970, *B.L. Turner 6063* (HOLOTYPE: TEX!; ISOTYPES: MEXU!, MICH!).

10. Xanthisma rhizomatum (M.C. Johnston) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Haplopappus rhizomatus* M.C. Johnston, Rhodora 63:177. 1961. *Machaeranthera heterophylla* R.L. Hartman, Phytologia 68:445. 1990, nom. nov., non *Machaeranthera rhizomata* A. Nelson & J.F. Macbride, Bot. Gaz. (Crawfordsville) 62:148. 1916. TYPE: MEXICO. NUEVO LEÓN: Saltillo-Matehuala highway, 5 mi N of junction of the side road to Galeana, 6000 ft, 8 Oct 1959, *J. Graham & M.C. Johnston 4203* (HOLOTYPE: TEX!; ISOTYPES: KANU!, MEXU!).

Xanthisma section **Sideranthus** (Nutt. ex Nees) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Sideranthus* Nutt. ex C. Nees in M. Wied-Neuwied, Reise Nord-America 2:440. 1841. *Dieteria* section *Sideranthus* (Nutt. ex Nees) Nutt. ex Walpers, Repert. Bot. Syst. 2:587. 1843. *Machaeranthera* section *Sideranthus* (Nutt. ex Nees) R.L. Hartman, Phytologia 68:456. 1990. TYPE: *Amellus spinulosus* Pursh.

Machaeranthera section *Stenoloba* R.L. Hartman, Phytologia 68:459. 1990. TYPE: *Eriocarpum stenolobum* Greene.

Herbs taprooted annuals, biennials, or perennials, 3–80 cm tall, sometimes with a much branched caudex. **Leaves** entire, serrate, dentate, or pinnatifid to deeply bipinnatifid, teeth or lobes usually bristle tipped, often markedly so. **Heads** radiate. **Involucres** broadly turbinate to depressed campanulate or hemispheric. **Phyllaries** in 4–8 graduated series, linear to narrowly oblong, the lower portion rigid, light green to stramineous, the upper fifth to half with a green patch or strip (sometimes blackish near apex), usually pubescent, often with glandular hairs, appressed to squarrose; apices obtuse to acuminate, usually tipped by a stiff and often pronounced bristle. **Receptacles** usually alveolate, scales 0.4–3 mm long, distinct or forming a reticulum. **Ray floret** corollas yellow. **Cypselae** often dimorphic, 1.5–3.2 mm long, elliptic to broadly obovate or obscurely and narrowly cordate, walls thin with 6–16 nerves or prominent ribs, glabrous to densely pubescent; ray cypselae usually rounded on dorsal edge, obscurely 3 sided, often asymmetrical, and slightly shorter; disc cypselae flattened laterally. **Pappus** white to tawny; bristles 3.5–6 mm long, slightly to moderately dorsiventrally flattened basally, in 2–4 markedly graduated series, those of the ray florets sometimes reduced in length. $n = 2, 3, 4, 8$.

11. Xanthisma arenarium (Benth.) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Haplopappus arenarius* Benth., Bot. Voy. Sulphur 24. 1844, "*Aplopappus.*" *Machaeranthera arenaria* (Benth.) Shinners, Field & Lab. 18:40. 1950. TYPE: MEXICO. BAJA CALIFORNIA SUR: Cabo San Lucas, 1841, *R. B. Hinds s.n.* (HOLOTYPE: K, photo at DS!).

12. Xanthisma gracile (Nutt.) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Dieteria gracilis* Nutt., Proc. Acad. Nat. Sci. Philadelphia 4:22. 1848. *Haplopappus gracilis* (Nutt.) A. Gray, Pl. Fendler. 76. 1849, "*Aplopappus*," non T.S. Brandegee, 1889.

Aster dieteria O. Kuntze, Revis. Gen. Pl. 1:315. 1891, based on *Dieteria gracilis* Nutt. *Eriocarpum gracile* (Nutt.) Greene, Erythea 2:109. 1894. *Sideranthus gracilis* (Nutt.) A. Nelson, Bot. Gaz. (Crawfordsville) 37:266. 1904. *Machaeranthera gracilis* (Nutt.) Shinners, Field & Lab. 18:41. 1950. TYPE: U.S.A. NEW MEXICO: near Santa Fe, s.d., *W. Gambel s.n.* (HOLOTYPE: GH!; ISOTYPE: K).

Haplopappus ravenii R.C. Jackson, Amer. J. Bot. 49:123. 1962. TYPE: U.S.A. ARIZONA. Yavapai Co.: open oak grasslands near Johnson Wash, ca. 10 mi S of the Verde River, 8 Jun 1959, *R.C. Jackson 2680* (HOLOTYPE: KANU!).

13. Xanthisma junceum (Greene) D.R. Morgan & R.L. Hartman, comb. nov.
BASIONYM: *Haplopappus junceus* Greene, Bull. Calif. Acad. Sci. 1:190. 1885, "*Aplopappus.*" *Eriocarpum junceum* (Greene) Greene, Erythea 2:108. 1894. *Sideranthus junceus* (Greene) A. Davidson & Moxley, Fl. S. Calif. 377. 1923. *Machaeranthera juncea* (Greene) Shinners, Field & Lab. 18:40. 1950. TYPE: U.S.A. CALIFORNIA. San Diego Co.: Cleveland, s.d., *M.K. Curran s.n.* (lectotype designated from among two syntypes by Hall 1928 with no indication of location; it was not found in the following relevant herbaria: CAS, DS, NDG, UC, RSA).

14. Xanthisma spinulosum (Pursh) D.R. Morgan & R.L. Hartman, comb. nov.
BASIONYM: *Amellus spinulosus* Pursh, Fl. Amer. Sept. 2:564. 1813. *Haplopappus spinulosus* (Pursh) DC., Prodr. 5:347. 1836, "*Aplopappus*," non Phil., 1873, nec T.S. Brandegee, 1889. *Starkea pinnata* Nutt., Gen. N. Am. 2:169. 1818, *nom. superf.* *Machaeranthera pinnata* Shinners, Field & Lab 18:41. 1950, non *Machaeranthera spinulosa* Greene, 1899. *Dieteria spinulosa* (Pursh) Nutt., Trans. Amer. Philos. Soc., ser. 2, 7:301. 1841. *Eriocarpum spinulosum* (Pursh) Greene, Erythea 2:108. 1894. *Sideranthus spinulosus* (Pursh) R. Sweet ex Rydb., Bull. Torrey Bot. Club 27:621. 1900. TYPE: U.S.A. [SOUTH DAKOTA. Lyman or Brule Co.: Reveal et al. 1999], in open prairies on the Missouri, 15 Sep 1804, *M. Lewis s.n.* (LECTOTYPE: PH! [designated by Hall 1928]; ISOLECTOTYPE: UC!).

Diplopappus pinnatifidus Hook. f., Fl. Bor.-Amer. 2:22. 1834. *Aster pinnatifidus* (Hook. f.) O. Kuntze, Revis. Gen. Pl. 1:313. 1891. *Machaeranthera pinnatifida* (Hook. f.) Shinners, Sida 1:295. 1964, nom. nov., non *Machaeranthera spinulosa* Greene, Pittonia 4:24. 1899. TYPE: CANADA. SASKATCHEWAN: Rocky Mountains near Jasper's Lake, s.d., *Drummond s.n.* (HOLOTYPE: K).

Haplopappus spinulosus (Pursh) DC. var. *canescens* A. Gray, P. Fendler 75. 1849, "*Aplopappus.*" TYPE: U.S.A. NEW MEXICO: between Santa Fe and the Rio del Norte, May 1847, *A. Fendler 395* (HOLOTYPE: GH!).

Eriocarpum wootonii Greene, Bull. Torrey Bot. Club 25:120, pl. 330, fig. 1, 2. 1898. *Sideranthus wootonii* (Greene) Standley, Contr. U.S. Natl. Herb. 13:222. 1910. TYPE: U.S.A. NEW MEXICO: White Mountains, 19 Aug 1897, *E.O. Wooton 518* (HOLOTYPE: NDG!; ISOTYPES: NY!, UC!).

Sideranthus puberulus Rydb., Bull. Torrey Bot. Club 27:622. 1900. TYPE: U.S.A. COLORADO. Chaffee Co.: Salida, s.d., *C.B. Clarke 174* (HOLOTYPE: NY!; ISOTYPE: UC!).

Sideranthus turbinellus Rydb., Bull. Torrey Bot. Club 27:622. 1900. *Haplopappus spinulosus* (Pursh) DC. var. *turbinellus* (Rydb.) S.F. Blake, Contr. Gray Herb. 52:23. 1917, "*Aplopappus.*" TYPE: U.S.A. IDAHO. Bannock Co.: Pocatello, 25 Aug 1892, *A.I. Mulford s.n.* (HOLOTYPE: NY!; ISOTYPE: UC!).

Sideranthus machaeranthera J.K. Small, Fl. S.E. U.S. 1186. 1903. TYPE: U.S.A. TEXAS: in dry soil, along the Brazos River, 1852, *A.C. Schott 508a* (HOLOTYPE: NY!; ISOTYPE: UC!).

Sideranthus cotula J.K. Small, Fl. S.E. U S 1186. 1903. *Haplopappus spinulosus* (Pursh) DC. subsp. *cotula* (J.K. Small) H.M. Hall, Publ. Carnegie Inst. Wash. 389:77. 1928. TYPE: U.S.A. OKLAHOMA (Indian Territory): Cherokee Town and vicinity, 1868, *E. Palmer 442A* (HOLOTYPE: NY!).

Sideranthus laevis Wooton & Standley, Contr. U.S. Natl. Herb. 16:180. 1913. *Haplopappus spinulosus* (Pursh) DC. subsp. *laevis* (Wooton & Standley) H.M. Hall, Publ. Carnegie Inst. Wash. 389:78. 1928. *Machaeranthera laevis* (Wooton & Standley) Shinners, Field & Lab. 18:40. 1950. TYPE: U.S.A. NEW MEXICO. Eddy Co.: gypsum hills near Lakewood, 6 Aug 1909, *E.O. Wooton s.n.* (HOLOTYPE: US!; ISOTYPES: UC!, US!).

Haplopappus texensis R.C. Jackson, Rhodora 64:142. 1962. *Machaeranthera texensis* (R.C. Jackson) Shinners, Sida 1:378. 1964. TYPE: U.S.A. TEXAS. Brooks Co.: sandy soil along railroad right-of way about 7.5 mi S of Falfurrias, 7 Aug 1959, *R.C. Jackson 2938-1* (HOLOTYPE: KANU!).

The following two binomials are not valid as the genus *Sideranthus* was a nomen nudum when the combinations were published: *Sideranthus pinnatifidus* Nutt., Fraser's Catalogue, no. 81, 1813, non *Aplopappus pinnatifidus* Nutt., 1840 and *Sideranthus spinulosus* (Pursh) Sweet, Hort. Brit., 227. 1826. Furthermore, *Eriocarpum australe* Greene (Erythea 2:108. 1894) although validly published has never been lectotypfied. The relevant synonyms are: *Sideranthus australis* (Greene) Rydb., Bull. Torrey Bot. Club 27:621. 1900; *Haplopappus spinulosus* (Pursh) DC. subsp. *australis* (Greene) H.M. Hall, Publ. Carnegie Inst. Wash. 389:77. 1928; and *Machaeranthera australis* (Greene) Shinners, Field & Lab. 18:42. 1950.

Xanthisma spinulosum "is an exceedingly complex, variable taxon. It is doubtful that any 'absolute' key can be constructed so as to recognize unequivocally the infraspecific categories proposed here. Instead, we have composed a key that attempts to recognize character *trends*, in combination, that serve to distinguish a given taxon from another, but the occasional (if not frequent) specimen will be found that keys to a given regional variety but belongs to yet another. However, if one accepts the exception and recognizes our account as an attempt to portray quite variable, *regional populations* and not as a key to individuals, then little trouble would be experienced in pinning a varietal name on this or that collection" (Turner & Hartman 1976). The following key is adapted from the aforementioned source.

KEY TO THE VARIETIES OF *XANTHISMA SPINULOSUM*

1. Involucres of pressed heads 15–25 mm wide, heads mostly sol'tary on elongate peduncles 2–15 cm or more long (shorter in Baja California, Mexico); herbs and subshrubs mostly (30–)50–100 cm tall; foliage relatively sparse, crowded below, internodes at mid-stem 0.5–2 mm or more long (short in Baja California, Mexico); W Colorado to S California and Arizona; Baja California, Mexico and vicinity.
2. Heads borne on elongate, leafy "peduncles," tne upper leaves not mucn reduced, subspinose; subshrubs up to 100 cm tall _____ **14d. X. spinulosum** var. **gooddingii**
2. Heads borne on relatively short, leafy "peduncles," the upper leaves not much reduced nor subspinose; perennial herbs, but often woody below or at the crown, mostly 30–60 cm tall.
3. Heads broadly campanulate; lower leaves generally 2–3 cm long, pinnatisect; W Colorado, adjacent Utah, New Mexico, and Arizona _____ **14f. X. spinulosum** var. **paradoxum**

3. Heads broadly turbinate to campanulate; lower leaves 0.5–2 cm long, dentate to nearly incised leaves; Baja California, Mexico.
   4. Involucres of pressed heads 22–25 mm wide; leaves large, decidedly incised; coastal islands _____ **14e. X. spinulosum** var. **incisifolium**
   4. Involucres of pressed heads 15–20 mm wide; leaves small and nearly serrate or dentate; widespread on mainland _____ **14g. X. spinulosum** var. **scabrellum**

1. Involucre of pressed heads 8–15 mm wide, heads mostly 2 to 10 or more per stem on relatively terminal and lateral peduncles 0.5–2 cm long; herbs mostly 20–50 cm tall; foliage abundant and not much reduced upwards, internodes at mid-stem 0.2–0.5 cm or less long.
   5. Stems stiffly erect, mostly unbranched, foliage glabrate or nearly so; heads nearly sessile; pappus bristles profuse, exceeding the disc corollas; South Dakota to N Texas _____ **14c. X. spinulosum** var. **glaberrimum**
   5. Stems spreading to sprawling, usually much-branched, foliage variously pubescent, rarely glabrous; pappus less pronounced in the head, equaling the disc corolla; widespread, W Canada to SW U.S.A.; central Mexico.
      6. Involucres of pressed heads 8–12 mm wide; stems equally leafy throughout; plants only rarely stiffly erect or woody at the base, mostly 10–40 cm tall; widespread _____ **14a. X. spinulosum** var. **spinulosum**
      6. Involucres of pressed heads 12–16 mm wide; stems mostly leafy below, upper leaves much reduced giving the heads a "long-peduncled" appearance; plants stiffly erect and often woody at the base, mostly 30–50 cm tall; W Texas, S New Mexico, S Arizona; N Mexico _____ **14b. X. spinulosum** var. **chihuahuanum**

(i) Xanthisma spinulosum subsp. **spinulosum**

14a. Xanthisma spinulosum var. **spinulosum**

14b. Xanthisma spinulosum var. **chihuahuanum** (B.L. Turner & R.L. Hartman) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera pinnatifida* (Hook. f.) Shinners var. *chihuahuana* B.L. Turner & R.L. Hartman, Wrightia 5:311. 1976. *Haplopappus spinulosus* (Pursh) DC. var. *chihuahuanus* (B.L. Turner & R.L. Hartman) K.N. Gandhi, Phytologia 69:276. 1990. TYPE: MEXICO. CHIHUAHUA: Sierra del las Monillas, ca. 16 mi SE of El Morreon on road to lake on Rio Conchos, 13 Jul 1972, *A. M. Powell 2447* (HOLOTYPE: TEX!).

14c. Xanthisma spinulosum var. **glaberrimum** (Rydb.) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Sideranthus glaberrimus* Rydb., Bull. Torrey Bot. Club 27:621. 1900. *Sideranthus spinulosus* (Pursh) R. Sweet ex Rydb. var. *glaberrimus* (Rydb.) A. Nelson, in J.M. Coulter & A. Nelson, Man. Bot. Rocky Mt. 499. 1909. *Haplopappus spinulosus* (Pursh) DC. var. *glaberrimus* (Rydb.) S.F. Blake, Contr. Gray Herb. 52:24. 1917, "*Aplopappus*." *Haplopappus spinulosus* (Pursh) DC. subsp. *glaberrimus* (Rydb.) H.M. Hall, Publ. Carnegie Inst. Wash. 389:77. 1928. *Machaeranthera pinnatifida* (Hook. f.) Shinners forma *glaberrima* (Rydb.) McGregor, Trans. Kansas Acad. Sci. 60:162. 1957. *Machaeranthera pinnatifida* (Hook. f.) Shinners var. *glaberrima* (Rydb.) B.L. Turner & R.L. Hartman, Wrightia 5:311. 1976. TYPE: U.S.A. NEBRASKA. Thomas Co.: Middle Loup River near Thedford, 19 Aug 1893, *P.A. Rydberg 1403a* (HOLOTYPE: NY!; ISOTYPES: GH!, US!).

(ii) Xanthisma spinulosum subsp. **gooddingii**

14d. Xanthisma spinulosum var. **gooddingii** (A. Nelson) D.R. Morgan & R.L.

Hartman comb. nov. BASIONYM: *Sideranthus gooddingii* A. Nelson, Bot. Gaz. (Crawfordsville) 37:266. 1904. *Haplopappus gooddingii* (A. Nelson) Munz & I.M. Johnston, Bull. Torrey Bot. Club 49:44. 1922, "*Aplopappus.*" *Haplopappus spinulosus* Pursh) DC. subsp. *gooddingii* (A. Nelson) S.F. Blake, Contr. U.S. Natl. Herb. 25:543. 1925, "*Aplopappus.*" *Machaeranthera pinnatifida* (Hook. f.) Shinners subsp. *gooddingii* (A. Nelson) B.L. Turner & R.L. Hartman, Wrightia 5:313. 1976. *Machaeranthera pinnatifida* (Hook. f.) Shinners var. *gooddingii* (A. Nelson) B.L. Turner & R.L. Hartman, Wrightia 5:314. 1976. TYPE: U.S.A. NEVADA: "The Pockets," 30 Apr 1902, *L.N. Goodding 667* (HOLOTYPE: RM!, ISOTYPE: US!).

Sideranthus viridis J.N. Rose & Standley, Contr. U.S. Natl. Herb. 16:19, pl. 15. 1912. TYPE: MEXICO. SONORA: Pinacate Mountains, 21 Nov 1907, *D.T. MacDougal s.n.* (HOLOTYPE: US!; ISOTYPE: UC!).

14e. Xanthisma spinulosum var. **incisifolium** (I.M. Johnston) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Haplopappus arenarius* Benth. var. *incisifolius* I.M. Johnston, Proc. Calif. Acad. Sci., ser. 4, 12:1190. 1924, "*Aplopappus.*" *Haplopappus spinulosus* (Pursh) DC. subsp. *incisifolius* (I.M. Johnston) H.M. Hall, Publ. Carnegie Inst. Wash. 389:75. 1928. *Machaeranthera pinnatifida* (Hook. f.) Shinners var. *incisifolia* (I.M. Johnston) B.L. Turner & R.L. Hartman, Wrightia 5:315. 1976. *Machaeranthera incisifolia* (I.M. Johnston) G.L. Nesom, Phytologia 69:112. 1990. TYPE: MEXICO. BAJA CALIFORNIA: S San Lorenzo Island, 9 May 1921, *I.M. Johnston 3529* (HOLOTYPE: CAS!; ISOTYPES: NY!, UC!).

14f. Xanthisma spinulosum var. **paradoxum** (B.L. Turner & R.L. Hartman) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera pinnatifida* (Hook. f.) Shinners var. *paradoxa* B.L. Turner & R.L. Hartman, Wrightia 5:314. 1976. *Haplopappus spinulosus* (Pursh) DC. var. *paradoxus* (B.L. Turner & R.L. Hartman) Cronquist, Intermountain Fl. 5:199. 1994. TYPE: U.S.A. COLORADO. Montrose Co.: Paradox, 21 Jun 1912, *E. P. Walker 147* (HOLOTYPE: NY!; ISOTYPES: DS!, GH!, RM!, US!).

14g. Xanthisma spinulosum var. **scabrellum** (Greene) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Eriocarpum scabrellum* Greene, Erythea 2:108. 1894. *Haplopappus spinulosus* (Pursh) DC. var. *scabrellus* (Greene) S.F. Blake, Contr. Gray Herb. 52:24. 1917, "*Aplopappus.*" *Haplopappus spinulosus* (Pursh) DC. subsp. *scabrellus* (Greene) H.M. Hall, Publ. Carnegie Inst. Wash. 389:74. 1928. *Machaeranthera scabrella* (Greene) Shinners, Field & Lab. 18:42. 1950. *Machaeranthera pinnatifida* var. *scabrella* (Greene) B.L. Turner & R.L. Hartman, Wrightia 5:314. 1976. TYPE: MEXICO. BAJA CALIFORNIA: foothills Los Angeles Bay, Dec 1887, *E. Palmer 539* (HOLOTYPE: NDG!; ISOTYPE: NY!).

Haplopappus arenarius Benth. var. *rossii* I.M. Johnston, Proc. Calif. Acad. Sci., ser 4, 12:1191. 1924. "*Aplopappus.*" TYPE: MEXICO. BAJA CALIFORNIA SUR: on margin of a gypsum mesa, San Marcos Island, 12 May 1921, *I.M. Johnston 3627* (HOLOTYPE: CAS!; ISOTYPE: US!).

15. Xanthisma stenolobum (Greene) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Eriocarpum stenolobum* Greene, Erythea 2:109. 1894. *Haplopappus stenolobus* (Greene) H.M. Hall, Publ. Carnegie Inst. Wash. 389:65. 1928. *Machaeranthera stenoloba* (Greene) Shinners, Field & Lab. 18:40. 1950. TYPE: MEXICO. CHIHUAHUA: Sierra Madre, Arroyo Ancho, 16 Oct 1887, *C.G. Pringle 1303* (HOLOTYPE: NDG!; ISOTYPES: GH!, NY!, PH!).

16. Xanthisma wigginsii (S.F. Blake) D.R. Morgan & R.L. Hartman, comb. nov.

BASIONYM: *Haplopappus wigginsii* S.F. Blake, Proc. Biol. Soc. Wash. 48:169. 1935, "*Aplopappus.*" *Machaeranthera wigginsii* (S.F. Blake) R.L. Hartman, Phytologia 68:458. 1990. TYPE: MEXICO. BAJA CALIFORNIA: Sierra San Pedro Mártir, 18 Sep 1930, *I. L. Wiggins & D. Demaree 4914* (HOLOTYPE: US!).

Xanthisma section **Havardii** (R.C. Jackson) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Haplopappus* section *Havardii* R.C. Jackson, Univ. Kansas Sci. Bull. 46:479. 1966. *Machaeranthera* section *Havardii* (R.C. Jackson) R.L. Hartman, Phytologia 68:458. 1990.

Herbs taprooted annuals, 15–45 cm tall. **Leaves** serrate or dentate, often coarsely so, teeth blunt or terminating in stiff callosities, not bristle-tipped. **Heads** radiate. **Involucres** broadly turbinate. **Phyllaries** in 5–7 graduated series, linear to narrowly oblong, the lower portion rigid, stramineous, the upper fifth to half with a green patch or strip, densely glandular, appressed; apices obtuse to acute. **Receptacles** alveolate, scales 0.1–0.5 mm long, mostly distinct. **Ray floret** corollas yellow. **Cypselae** essentially similar, 2.5–3 mm long, oblong or narrowly elliptic, sometimes slightly asymmetrical, flattened laterally, walls thin with 12–14 barely discernible nerves, sparsely pubescent. **Pappus** similar in ray and disc florets, white; bristles 5–7 mm long, filiform, not dorsiventrally flattened basally, in 2–3 poorly defined series. $n = 4$.

17. Xanthisma viscidum (Wooton & Standley) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Sideranthus viscidus* Wooton & Standley, Contr. U.S. Natl. Herb. 16:180. 1913. *Haplopappus viscidus* (Wooton & Standley) S.F. Blake, J. Wash. Acad. Sci. 28:486. 1938. *Machaeranthera viscida* (Wooton & Standley) R.L. Hartman, Phytologia 68:459. 1990. TYPE: U.S.A. NEW MEXICO. Eddy Co.: near Hope, 3 Aug 1905, *E.O. Wooton s.n.* (HOLOTYPE: US!).

Haplopappus havardii Waterfall, Rhodora 45:352. 1943. *Machaeranthera havardii* (Waterfall) Shinners, Field & Lab. 18:40. 1950. TYPE: U.S.A. TEXAS. Culberson Co.: 9 mi E of Van Horn, s.d., *U.T. Waterfall 4153* (HOLOTYPE: GH!; ISOTYPES: ARIZ!, MO!, NY!).

Arida D.R. Morgan & R.L. Hartman, comb. et stat. nov. BASIONYM: *Machaeranthera* section *Arida* R.L. Hartman, Phytologia 68:446. 1990. TYPE: *Machaeranthera arida* B.L. Turner & D.B. Horne.

Herbs taprooted annuals or rarely short lived perennials (often much branched, rhizomatous, forming vegetative rosettes in *A. blepharophylla*), 10–60(–80) cm tall. **Stems** erect to ascending or sprawling, often much branched, glabrous to variously pubescent with glandular and nonglandular hairs. **Leaves** alternate; entire, dentate, lacerate to deeply pinnatifid or bipinnatifid, glabrous to densely pubescent with glandular or nonglandular hairs, apices, including lobes and teeth, apiculate to bristle tipped, bristles 0.1–1 mm long. **Heads** radiate or eradiate. **Involucres** turbinate to depressed hemispheric. **Phyllaries** in 4–8 imbricate series, graduated in length, appressed, spreading, or reflexed, glabrous or moderately to densely pubescent with glandular or nonglandular hairs; bases indurate to herbaceous, apices herbaceous, margins sometimes scarious.

Receptacles indistinctly alveolate, convex, naked or nearly so, or (in *A. blepharophylla*) with scales up to 0.5 mm long. **Ray florets** pistillate, fertile (absent in *A. carnosa*); corollas light to dark blue. **Disc florets** bisexual, fertile, corollas yellow, ± funnelform, tubes and limbs generally glabrous, lobes 0.3–0.5 mm long, glabrous to minutely pubescent. **Cypselae** of ray and disc florets somewhat dimorphic, narrowly oblong, moderately to densely pubescent; thin walled, with 5–11 filiform nerves per face, 1–3.2(–4) mm long, those of ray florets, if present, obscurely 3 sided, rounded abaxially, of disc florets only slightly compressed laterally; pappus white or whitish (tawny in *A. blepharophylla*), of ray florets 1/3 to nearly equaling length of disc florets; bristles minutely barbellate, in 2–3 poorly differentiated series, at most somewhat dorsi-ventrally flattened and dissimilar in width near base, bases not to slightly overlapping, mostly 2.5–4.5(–5) mm long. $n = 5$.

Four of the nine species that are here included in *Arida* (*A. blepharophylla*, *A. parviflora*, *A. riparia*, and *A. turneri*) were included in molecular investigations of *Machaeranthera* s.l. (Morgan & Simpson 1992; Morgan 1997, 2003). The conflicting relationships supported by cpDNA and nrDNA for these species suggested substantial reticulate evolution among the four species and with species of *Dieteria*, *Pyrrocoma*, and *Xanthisma*, complicating efforts to produce a taxonomy that best reflects current understanding of the systematics of *Arida*.

In classifying the species of *Arida*, one issue to consider is the proper taxonomy for *A. blepharophylla*. Chloroplast DNA and nrDNA supported conflicting relationships for this species (Fig. 1), suggesting that it has experienced reticulate evolution (Morgan 1997, 2003). Since the taxonomy of *A. blepharophylla* should match its evolutionary history as closely as possible, it would be desirable to base its classification on what kind of reticulate evolution has occurred. As described by Morgan (1997), there are two major possibilities. First, because *A. blepharophylla* exhibits characteristics of both parental lineages, it could have originated through hybrid speciation; the best treatment in this situation might be to establish *A. blepharophylla* as a monospecific genus descended from, but separate from, both parental lineages.

The second evolutionary possibility is that *A. blepharophylla* is a close relative of *A. riparia* that has acquired chloroplast DNA from the ancestor of *Xanthisma gymnocephalum*; the best treatment in this case might be to classify it with *A. riparia*. Here we choose the latter disposition. According to nrDNA evidence, the nuclear relationships of *A. blepharophylla* are with *A. riparia*. In addition, the majority of its characteristics, including chromosome number and fruit morphology, are shared with *A. riparia* rather than with *X. gymnocephalum* (Nesom et al. 1990). It is possible that *Arida blepharophylla* is a hybrid species, but in our view additional genetic data would be necessary to convincingly demonstrate the occurrence of hybrid speciation. In the absence of such data we propose that *A. blepharophylla* be considered a close relative of

A. riparia that has experienced chloroplast introgression, and that its taxonomy reflect this history.

With *Arida blepharophylla* classified with *A. riparia*, the next question is whether the nine species of *Arida* should all be maintained in the same genus. If *A. blepharophylla* is placed with *A. riparia* as described above, cpDNA evidence would support keeping all the species together because it supported a group composed of *A. parviflora*, *A. turneri*, and *A. riparia* (Fig. 1). However, nrDNA evidence separated these four species into two lineages (Fig. 1). As described in detail by Morgan (2003), there are two primary explanations for this conflict, both involving reticulate evolution. The first explanation considers the alliances supported by nrDNA to be closer to the true species relationships. The corresponding classification would split *Arida* into two parts.

The second explanation considers the alliances supported by cpDNA to be closer to the species relationships for *Arida*. In supporting the group composed of *A. parviflora*, *A. turneri*, and *A. riparia*, cpDNA evidence suggested that the two lineages of *Arida* are closest relatives. In this case, the corresponding taxonomy would keep the two lineages together, retaining all species of *Arida* in the same genus. This is the classification adopted here because, in addition to cpDNA, several additional pieces of evidence support this treatment. All species of *Arida* have $n = 5$, all that have been investigated produce flavones, and hybridization experiments suggest much genetic similarity between the two lineages (Turner & Horne 1964; Turner et al. 1975; Stucky 1978; Hartman 1976, 1990; Nesom et al. 1990). This array of characteristics unites the species of *Arida* and distinguishes them from other taxa in the *Machaeranthera* complex; we interpret the conflicting results from nrDNA data as resulting from nrDNA introgression, as explained by Morgan (2003).

The following key is based in part on data in Hartman (1976, 1990), Nesom (2003), Nesom et al. (1990), and Turner (1986). It includes the new species *Arida mattturneri* (Turner & Nesom 2003).

KEY TO THE SPECIES OF *ARIDA*

1. Ray cypselae pappose (heads eradiate in *A. carnosa*).
   2. Leaves entire to toothed.
      3. Ray florets absent _____ **3. Arida carnosa**
      3. Ray florets present.
         4. Plants annual; leaf margins entire and glabrous or with 1–8 teeth per side, each spinulose tipped; involucres hemispheric, 10–16 mm wide when fresh; phyllaries linear lanceolate to oblong lanceolate, narrowly acute to acuminate or attenuate _____ **8. Arida riparia**
         4. Plants perennial, rhizomatous, forming vegetative rosettes; leaf margins essentially entire with 8–20 cilia or bristles per side, cilia 0.4–0.8(–1.5) mm long; involucres turbinate, 5–8 mm wide when fresh; phyllaries oblong ovate to obovate, broadly acute to short acuminate _____ **2. Arida blepharophylla**

2. Leaves (at least some) pinnatifid to bipinnatifid.
   5. Receptacles 8–11 mm wide; phyllary apices spreading to reflexed _____ **9. Arida turneri**
   5. Receptacles 2–7 mm wide; phyllary apices mostly appressed _____ **7. Arida parviflora**

1. Ray cypselae epappose (except in occasional plants).
   6. Mid-stems essentially glabrous or with few sessile glands.
      7. Leaves deeply pinnatifid; SW Colorado, N New Mexico, Utah, and E Arizona; Chihuahua and Coahuila, Mexico _____ **7. Arida parviflora**
      7. Leaves above basal rosette, if present, entire or toothed.
         8. Stems 10–45 cm long, weakly ascending to procumbent; SW Sonora, Mexico _____ **4. Arida coulteri**
         8. Stems 50–80 cm long, erect; W Texas _____ **6. Arida mattturneri**
   6. Mid-stems densely glandular pubescent.
      9. Involucres 3–6 mm tall, 5–10 mm wide; mid-stems densely glandular, also with longer, crisp, nonglandular hairs interspersed; S Nevada, S California, S Arizona; N Sonora, Mexico _____ **1. Arida arizonica**
      9. Involucres 6–8 mm tall, 10–15 mm wide; mid-stems densely glandular, nonglandular hairs absent; N Baja California Sur and adjacent W Sonora, Mexico _____ **5. Arida crispa**

1. Arida arizonica (R.C. Jackson & R.R. Johnson) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera arizonica* R.C. Jackson & R.R. Johnson, Rhodora 69: 476, fig. 1. 1967. TYPE: U.S.A. ARIZONA. Pima Co.: Oregan Pipe Cactus National Monument, low, rocky hillsides and sandy soils around Quitobaquito Springs, 31 Mar 1962, *R.C. Jackson & R.R. Johnson 3043-1* (HOLOTYPE: KANU!; ISOTYPES: ARIZ!, KANU!).

Machaeranthea arida B.L. Turner & D.B. Horne, Brittonia 16:324. 1964. *Machaeranthera coulteri* (A. Gray) B.L. Turner var. *arida* (B.L. Turner & D.B. Horne) B.L. Turner, Phytologia 61:144. 1986. TYPE: U.S.A. CALIFORNIA. San Bernardino Co., Mesquite Valley, 1.7 mi SW of Kingston, 2600 ft, 15 May 1941, *C.B. Wolf 10635* (HOLOTYPE: DS!; ISOTYPES: NY!, TEX!, UC!).

Machaeranthera ammophila Reveal, Bull. Torrey Bot. Club 97:172. 1970. TYPE: U.S.A. NEVADA. Nye Co.: Amargosa Desert, on the W edge of Ash Meadows, 0.3 mi W of Carson Slough, 21 Aug 1968, *J.L. Reveal & N.H. Holmgren 1882* (HOLOTYPE: US!; ISOTYPES: GH!, NY!, RM!).

2. Arida blepharophylla (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Aster blepharophyllus* A. Gray, Pl. Wright. 2:77. 1853. *Machaeranthera gypsitherma* G.L. Nesom, Vorobik, and R.L. Hartman, Syst. Bot. 15:638. 1990, nom. nov., non *Machaeranthera blephariphylla* (A. Gray) Shinners, Field & Lab. 18:38. 1950. TYPE: U.S.A. NEW MEXICO. Hidalgo Co.: in subsaline soil, Las Playas Springs, 7 Oct 1851, *C. Wright 1164* (LECTOTYPE: GH! [designated by Nesom et al.1990]; ISOLECTOTYPES: CGE, GH!, MO!, NY!, P, PH!).

3. Arida carnosa (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Linosyris carnosa* A. Gray, Pl. Wright. 2:80. 1853. *Aster carnosus* (A. Gray) A. Gray ex W. B. Hemsley, Biol. Cent.-Amer., Bot. 2:120. 1881, non J.-B. Gilibert, 1781. *Leucosyris carnosa* (A. Gray) E.L. Greene, Fl. Francisc. 384. 1897. *Machaeranthera carnosa* (A. Gray) G.L. Nesom, Phytologia 67:439. 1989. TYPE: MEXICO. SONORA: W of Chiricahui Mountains, Sep 1851, *C. Wright 1187* (HOLOTYPE: GH!; ISOTYPES: PH!, US!).

Bigelowia intricatus A. Gray, Proc. Amer. Acad. Arts 17:208. 1882. *Aster intricatus* (A. Gray) S.F. Blake, J. Wash. Acad. Sci. 27:378. 1937. *Machaeranthea carnosa* (A. Gray) G.L. Nesom var.

intricata (A. Gray) G.L. Nesom, Phytologia 82:106. 1997. TYPE: U.S.A. CALIFORNIA: Mohave Desert, at Lancaster Station, s.d., *C.C. Parry s.n.* (HOLOTYPE: GH!)

4. Arida coulteri (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Psilactis coulteri* A. Gray, Pl. Fendler. 72. 1849. *Machaeranthera coulteri* (A. Gray) B.L. Turner & D.B. Horne, Brittonia 16:322. 1964. TYPE: MEXICO. SONORA: probably the vicinity of Guaymas, n.d., *T. Coulter 295* (HOLOTYPE: GH!).

5. Arida crispa (T.S. Brandegee) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Psilactis crispa* T.S. Brandegee, Proc. Calif. Acad. Sci., ser. 2, 2:169. 1889. *Machaeranthera crispa* (T.S. Brandegee) B.L. Turner & D.B. Horne, Brittonia 16:321. 1964. TYPE: MEXICO. BAJA CALIFORNIA SUR: alkaline soil, San Joaquine, San Ignacio, 1 Apr 1889, *T.S. Brandegee s.n.* (HOLOTYPE: UC!; ISOTYPES: GH!, US!).

6. Arida mattturneri B.L. Turner & G.L. Nesom, Sida 20:1418. 2003. TYPE: U.S.A. TEXAS. Presidio Co.: ca. 2.2 mi NNW of Ruidosa in "Blumberg Canyon," (ca. 30° 00' 45" N, 104° 44' 00" W), 20 Jul 2003, *M.W. Turner 100* (HOLOTYPE: TEX; ISOTYPES: NY!, SRSC).

7. Arida parviflora (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera parviflora* A. Gray, Pl. Wright. 1:90. 1852. *Aster parviflorus* (A. Gray) A. Gray in W.H. Brewer & S. Watson, Bot. California 1:322. 1876, non C. Nees, 1818, nec W. Darlington, 1826. *Aster parvulus* S.F. Blake in Tidestrom, Contr. U.S. Natl. Herb. 25:563. 1925. TYPE: U.S.A. TEXAS: "collected in expedition from W Texas to El Paso, N. Mex.," May–Oct 1849, *C. Wright 271* (HOLOTYPE: GH!; ISOTYPES: NY!, US!).

Machaeranthera tanacetifolia (Kunth) C. Nees var. *pygmaea* A. Gray, Pl. Wright. 2:74. 1853. *Aster tanacetifolia* Kunth var. *pygmaeus* (A. Gray) A. Gray, Syn. Fl. N. Amer. 1(2):206. 1884. *Machaeranthera pygmaea* (A. Gray) Wooton & P.C. Standley, Contr. U.S. Natl. Herb. 16:189. 1913. TYPE: U.S.A. NEW MEXICO: near El Paso, 1851, *C. Wright 1395* (HOLOTYPE: GH!; ISOTYPES: NY!, US!).

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9. Arida turneri (M.L. Arnold & R.C. Jackson) D.R. Morgan & R.L. Hartman, comb. nov. BASIONYM: *Machaeranthera turneri* M.L. Arnold & R.C. Jackson, Syst. Bot. 3:209. 1979. TYPE: MEXICO. CHIHUAHUA: 3.3 mi N of Meoqui, along highway 45, 1 Aug 1964, *R.C. Jackson 4005* (HOLOTYPE: TTC!).

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A NEW SPECIES OF *ARIDA* (*MACHAERANTHERA* SECT. *ARIDA*—ASTERACEAE: ASTEREAE) FROM TRANS-PECOS, TEXAS

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ABSTRACT

Arida mattturneri Turner & Nesom, sp. nov., is described from collections made near Ruidosa in Presidio County, Texas. The plants are perennial, lavender-rayed, and occur in gypseous soils along shallow perennial streams and seeps. It is a member of *Machaeranthera* sect. *Arida*, now segregated as the genus *Arida*, and is similar to *Arida turneri* in significant respects, especially the bipinnately parted leaves. The new species is illustrated by photographs.

RESUMEN

Se describe **Arida mattturneri** Turner & Nesom, sp. nov., a partir de colecciones hechas cerca de Ruidosa, en Presidio County, Texas. Las plantas son perennes, rayadas de lavanda, y aparecen en suelos yesosos a lo largo de arroyos permanentes poco profundos y lugares rezumantes. Es un miembro de *Machaeranthera* sect. *Arida*, ahora segregado como género *Arida*, y es semejante a *Arida turneri* en aspectos importantes, especialmente en las hojas bipinnado-partidas. La nueva especie se ilustra mediante fotografías.

In the spring of 2001, Ms. Charmaine Delmatier of the U.S. Fish and Wildlife Service, Austin, Texas, collected sterile material of plants occurring along the gypseous, seepy walls of a canyon near Ruidosa, Texas (Presidio County), on the property of James Blumberg. She asked the senior author to identify the material concerned and, because of its peculiar habitat, there was little problem in tentatively identifying it as *Machaeranthera gypsitherma* Nesom, Vorobik, and Hartman (1990), a rare species previously unknown to Texas—it now apparently is extinct at its type locality in southern New Mexico and otherwise known from only a single population in Chihuahua, Mexico.

In a later visit to the Presidio County site (spring of 2003), to collect flowering material of this remarkable discovery, the present authors encountered essentially sterile material of yet another *Machaeranthera*, which is the subject of the present paper. The senior author, along with his son Matt and James Blumberg, revisited the site in the ensuing summer, at which time abundant flowering material of the plants concerned was collected. Examination of the material clearly indicates its status as a previously undescribed species.

We follow recent morphological and molecular studies and taxonomy of Ronald Hartman and David Morgan, as well as their forthcoming treatments

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for the Flora of North America volumes of Asteraceae, in dividing the species of *Machaeranthera* (sensu Hartman 1990) among four segregate genera, including *Machaeranthera* sensu stricto but not including *Psilactis* (sensu Morgan 1993). Nomenclatural combinations to formally effect these taxonomic changes are in this current issue of Sida (Morgan & Hartman 2003).

Arida mattturneri B.L. Turner & G. Nesom, sp. nov. (**Figs. 1, 2**). TYPE: UNITED STATES. TEXAS: Presidio Co.: ca. 2.2 mi NNW of Ruidosa in 'Blumberg Canyon,' growing along perennial sulphur streams and around tinajas (ca. 30° 00' 00" N, 104° 44' 00" W), 20 Jul 2003, *Matt W. Turner 100* (HOLOTYPE: TEX; ISOTYPES: NY, SRSC).

Aridae turneri (Arnold & Jackson) Morgan & Hartman similis vestimento glanduloso, foliis bipinnatifidis lobis mucronatis, flosculis radii lavandulaceis, acheniis 1.0–1.5 mm longis nervis tenuibus numerosis, et pappo brevi, sed differt plantis perennibus foliis basalibus persistentibus, capitulis minoribus flosculis radii paucioribus, phyllariis oblongi-lanceolatis apicibus rotundati acutis, et flosculis disci pappo carenti.

Perennial herbs from a thick, lignescent taproot, caudex simple, stems, leaves, and phyllaries sticky-viscid from resin globules exuded by sessile or minutely stipitate glands, without other kinds of hairs; leaves and phyllaries with indurate mucros but not bristle-tipped. **Stems** erect, 50–80 cm tall. **Leaves** basal and cauline, basal in persistent rosettes, bipinnately parted, abruptly passing into merely pinnately parted lower and midcauline, gradually reduced upwards into entire, scale-like bracts; basal 4–6 cm long, 1.5–3.5 cm wide, broadly obovate in outline, ultimate segments ovate to linear-lanceolate or linear. **Heads** ca. 10–13, terminal on elongate bracteate peduncles 5–10 cm long, collectively forming a broad, open capitulescence; involucres campanulate, 5–6 mm high, 6–8 mm wide, phyllaries in 5–6 graduate series, oblong-lanceolate, 1.0–1.5 mm wide, outermost 1–2 mm long, innermost 5–6 mm long, distal 1/3–1/2 slightly widened then rounded-acute, green and slightly turgid-thickened; receptacles plane, ca. 5 mm wide, glabrous. **Ray florets** 9–13, pistillate, fertile, tubes ca. 1.5 mm long, ligules 9–10 mm long, lavender, markedly drooping in full bloom, tightly coiling during fruit maturity. **Disc florets** 40–100, fertile, corollas narrowly cylindric, yellow, 3.5–4.5 mm long, tubes 1.2–1.5 mm long, grading into the nearly glabrous throats 2.0–2.8 mm long, lobes 5, narrowly deltoid, erect, 0.3–0.5 mm long. **Achenes** 1.0–1.5 mm long, obovate-oblong in outline, 8–12 nerved, compressed but more or less 3(–4) sided, densely sericeous; pappus of disc achenes of numerous whitish bristles mostly 3–4 mm long, in 2–3 series and variable in length on a single achene, absent on ray achenes. Chromosome number, $2n = 10$ (Powell 2003, this issue).

The species is named for the senior author's son, Matt Warnock Turner, who participated in collection of type materials. Matt once confided to his father that if ever a plant were to be named for him, he would like it to be very distinct, relatively rare, and confined to Texas. With such a pitch, the senior Turner de-

spaired of ever finding a plant with such stringent 'cultural' parameters. The present novelty fulfills all such requirements, and with considerable filial pride, he has proposed the name concerned. The name also is appropriate, since its close relative, *Arida turneri* (Arnold & Jackson) Morgan & Hartman, is named for his father, thus both the plants and their eponymy bear a genetic connection. We also note that Matt is a first-rate systematist, evidenced by his account of the southwestern U.S.A. species of *Baileya* (Turner 1993) and the more eastern *Brazoria* (Turner 1996).

Following Hartman's conspectus (1990) of the genus *Machaeranthera*, the features of *Arida mattturneri* place it as a member of sect. *Arida* R.L. Hartman (now genus *Arida* (R.L. Hartman) Morgan & Hartman): leaves without bristle-tipped lobes, ray corollas lavender, achenes 1.5–3 mm long with thin walls and numerous, thin, superficial nerves, and pappus of disc achenes of relatively short bristles, absent on ray achenes. The chromosome number of *A. mattturneri* is *n* = 5 (from plants at the type locality; Powell 2003), which is constant for other species of *Arida*. All other species of *Machaeranthera* (sensu Hartman 1990) have chromosome numbers based on x = 4.

Among taxa of *Arida*, the only previously described species with bipinnatifid leaves is *A. turneri*, which is here hypothesized to be a close relative of the new species. Both species also occur in close proximity to saline or gypseous seeps and springs. The two are distinguished as follows:

1. Plants perennial; basal leaves persistent; involucres 6–8 mm wide, receptacles ca. 5 mm wide; phyllaries oblong-lanceolate, 1.0–1.5 mm wide, distal 1/3–1/2 slightly widened, then with rounded-acute apices; ray florets 9–13, corollas 10–12 mm long, achenes epappose; disc corollas 3.5–4.5 mm long _____ **Arida mattturneri**
1. Plants annual; basal leaves deciduous before flowering; involucres 12 -17 mm wide, receptacles 8–11 mm wide; phyllaries linear-lanceolate, 0.8–1.0 mm wide inner with narrowly acute to acuminate apices; ray florets 41–59, corollas 11–15 mm long, achenes pappose; disc corollas 4.5–6.0 mm long _____ **Arida turneri**

Arnold and Jackson (1978), as well as Hartman (1990), observed that the closest relative of *Arida turneri* is *A.* (*Machaeranthera*) *parviflora* (A. Gray) Morgan & Hartman. As in *A. turneri*, plants of *A. parviflora* are annual with basal leaves deciduous before flowering, but the latter differs primarily in its smaller and less dissected leaves and smaller heads (shorter and narrower involucres and fewer and shorter ray and disc florets). Ray achenes in some populations of *A. parviflora* are epappose but pappose in others. Differences between the two species appear to be mainly quantitative, but they have been collected in close proximity apparently without intergrades. Even so, morphological evidence is equivocal in suggesting relationships among the three species under consideration, and it remains to be discovered whether the two annuals (*A. turneri* and *A. parviflora*) or the two with bipinnatifid leaves (*A. turneri* and *A. mattturneri*) are more closely related.



FIG. 1. Upper photo: four plants of *Arida mattturneri* at the type locality, April 2003. Lower photo: same plants in flower at same site, July 2003.

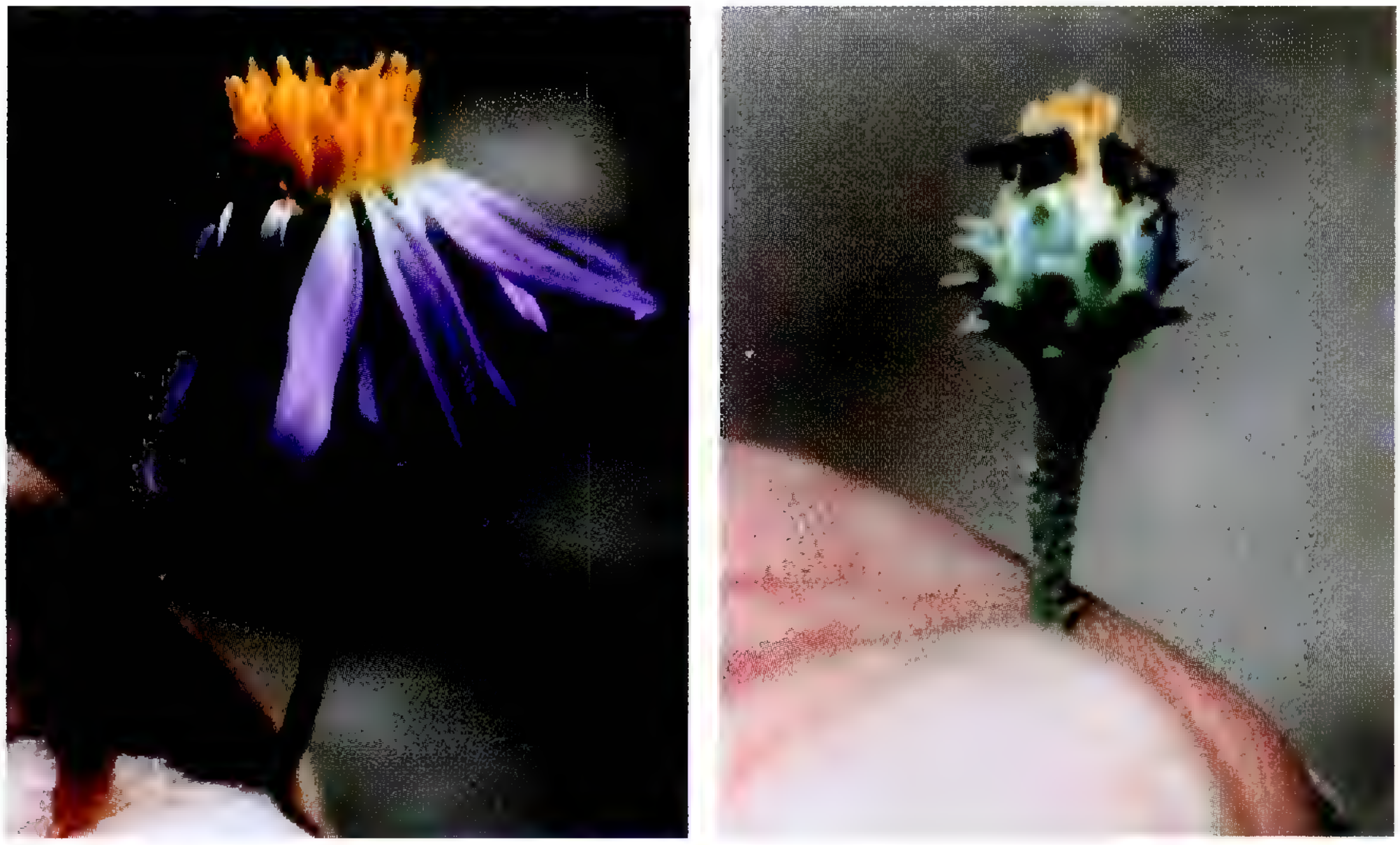


FIG. 2. Flowering heads showing (left, at anthesis) drooping ray corollas and (right, during fruit maturation) tightly coiled ray corollas and phyllaries with turgid, spreading apices.

When originally described, *Arida turneri* (as *Machaeranthera turneri*; Arnold and Jackson 1978) was primarily known by material from the vicinity of Meoqui, Chihuahua, Mexico, but subsequent collections have been made in Mpio. Julimes, Chihuahua, in the vicinity of Baños de San Diego (*McDonald 2549*, BRIT, TEX); *Nesom & Vorobik 5479*, TEX; and *Nesom 6543b*, TEX). The only other known extant locality for *Arida blepharophylla* (A. Gray) Morgan & Hartman (= *Machaeranthera gypsitherma*) also is Baños de San Diego, thus all three species in the discussion are rare and have similar ranges. *Arida mattturneri* is now the only one of the three known from only a single locality.

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FURTHER ADDITIONS TO THE GENUS *ARDISIA* SUBGENUS *GRAPHARDISIA* (MYRSINACEAE)

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ABSTRACT

Revision of the group of species formerly placed in *Oerstedianthus* Lundell revealed that the group is synonymous with *Ardisia* subgenus *Graphardisia* Mez. This paper incorporates those taxa in the subgenus, necessitating further revision of subgenus *Graphardisia*, including an emended description of the subgenus, a key to the species and subspecies, along with updated descriptions of the four added taxa and new illustrations for each. Four additional taxa are recognized, including one new species: *Ardisia verdisepala* Ricketson & Pipoly, and one new combination: *Ardisia nigrescens* subsp. *donnellsmithii* (Mez) Ricketson & Pipoly. Seven binomials are relegated to synonymy within *A. tuerckheimii* Donn. Sm. In addition, *Ardisia nigrescens* Oerst., *A. nigrescens* subsp. *donnellsmithii* (Mez) Ricketson & Pipoly and *A. tuerckheimii* Donn. Sm. are lectotypified.

RESUMEN

Una revisión del grupo de especies anteriormente clasificadas dentro del género *Oerstedianthus* Lundell reveló que el grupo se ubica mejor dentro del género *Ardisia* subgénero *Graphardisia* Mez, y por lo tanto se relega el género a la sinonimia. El propósito del presente trabajo es para incorporar ese grupo dentro del subgénero, y actualizar su circunscripción, claves para identificar las especies y subespecies, descripciones de ellas y nuevas ilustraciones para cada una. Se reconocen cuatro taxa adicionales, que incluye una especie nueva para la ciencia: *Ardisia verdisepala* Ricketson & Pipoly, y una nueva combinación: *Ardisia nigrescens* subsp. *donnellsmithii* (Mez) Ricketson & Pipoly. Se relegan siente binomiales a la sinonimia bajo *A. tuerckheimii* Donn. Sm. Además, se lectotipifican *Ardisia nigrescens* Oerst., *A. nigrescens* subsp. *donnellsmithii* (Mez) Ricketson & Pipoly y *A. tuerckheimii* Donn. Sm.

INTRODUCTION

The pantropical genus *Ardisia* Sw. is the largest within the Myrsinaceae, containing perhaps as many as 500 species (Chen & Pipoly 1996). Its circumscription has been problematic owing to a lack of comprehensive treatment since that of Mez (1902) in Engler's *Das Pflanzenreich* over a century ago. In preparation of our treatment of the Myrsinaceae for *Flora Mesoamericana*, we have critically reexamined taxa segregated by Lundell from *Ardisia*, including *Gentlea* (Ricketson & Pipoly 1997), *Graphardisia* (Pipoly & Ricketson 1998), *Chontalesia* and species related to it, now known to belong to the genus *Hymenandra* (Pipoly & Ricketson 1999a), *Zunilia* which is now known to belong to *Ardisia* subgen. *Graphardisia* (Pipoly & Ricketson 1999b), *Ardisia rarescens* Standl. which was

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placed in *Amatlania* by Lundell and is now known to belong to *Ardisia* subgen. *Acrardisia* (Pipoly & Ricketson 2000), *Auriculardisia*, *Amatlania* and *Valerioanthus* now all belonging to *Ardisia* subgen. *Auriculardisia* (Ricketson & Pipoly 2003) and the segregate genera, *Yunckeria* Lundell (=*Ctenardisia* Ducke) and *Ibarrea* Lundell (=*Ardisia* subgen. *Ardisia*). Since our study of the subgenus *Graphardisia* (Pipoly & Ricketson 1998, 1999b), including Lundell's segregate genera *Graphardisia* and *Zunilia*, it has become evident that the taxa comprising the segregate genus *Oerstedianthus* (Lundell 1981) are best placed within *Ardisia* subgenus *Graphardisia*.

According to Lundell (1981:139–140), "The genus [*Graphardisia*] is related to *Oerstedianthus* Lundell." He separated the two as follows:

"Filaments strictly glabrous; stems and inflorescence glabrous; punctations of all parts dense and blackish; bracts and bractlets usually foliaceous and often persistent; sepals and petals large, accrescent, usually blackened, usually ribbed or with dense elevated black glands _____ **Graphardisia**

Filaments pubescent with gland-tipped hairs; stems and inflorescence rarely glabrous, usually puberulent, hirtellous or dense hirsute tomentose; punctations of all parts conspicuous but not prominently raised, pellucid or rarely blackish; bracts and sepals small, not accrescent; sepals not ribbed with glands _____ **Oerstedianthus**"

However, our studies of *Ardisia* subgenus *Graphardisia* (Pipoly & Ricketson 1998, 1999b) have clearly shown the presence of raised or sessile glandular-papillate filaments in all taxa. In addition, because we are not sure of the polarity of this character state, or if it can have multiple origins, its utility is dubious. Foliar and other punctations are said to be inconspicuous in the taxa newly added in this work, but they are normally prominent and occasionally conspicuous. Finally, the sepals are generally small, but they are comparable to those found in other members of subgenus *Graphardisia*, (i.e., *Ardisia bartlettii* Lundell and *A. weberbaueri* Mez). Lundell (1981:141) also notes: "*Oerstedianthus* is related to *Graphardisia* (Mez) Lundell. Both have similar linear-lanceolate anthers which dehisce by apical pores." Therefore, we find it necessary to relegate the genus *Oerstedianthus* Lundell to synonymy under *Ardisia* subgenus *Graphardisia*.

TAXONOMIC TREATMENT

Ardisia subgenus **Graphardisia** Mez in Engl., Pflanzenr. IV. 236 (Heft 9):78. 1902; Lundell, Wrightia 3:192–198. 1966. *Graphardisia* (Mez) Lundell, Phytologia 48:139. 1981; Lundell, Phytologia 59:429–433. 1986. TYPE: *Ardisia opegrapha* Oerst. (LECTOTYPE, designated by Lundell, Phytologia 48:139. 1981).

Oerstedianthus Lundell, Phytologia 48:141. 1981. Syn. Nov. TYPE: *Ardisia nigrescens* Oerst. 1861:130. 1862. *Oerstedianthus nigrescens* (Oerst.) Lundell, Phytologia 48:141. 1981.

Zunilia Lundell, Phytologia 49:353. 1981. TYPE: *Ardisia sexpartita* Lundell, Wrightia 3:29. 1962. *Zunilia sexpartita* (Lundell) Lundell, Phytologia 49:354. 1981.

Subshrubs to trees. Branchlets mostly terete, glabrous, puberulent, hirsute or

rarely, glandular-granulose. **Leaves** petiolate; blades membranous to subcoriaceous, densely and prominently black (rarely pellucid-) punctate and punctate-lineate, the margins entire to crenulate or serrate. **Inflorescence** terminal, rarely lateral, pinnate to tripinnately paniculate, pyramidal to obpyramidal rarely globose, the ultimate branches corymbose, at times in high anthotactic spirals and thus appearing umbellate, the rachis often densely and prominently black punctate and punctate-lineate; inflorescence and floral bracts minute to foliaceous, caducous to persistent, often resembling the vegetative leaves but acropetally reduced in size. **Flowers** 5 or 6-merous, densely and prominently black punctate and punctate-lineate; calyx with sepals free or nearly free, large, accrescent and clasping fruits at maturity; corolla white, pink, lavender or purple, rotate, the lobes imbricate in bud, basally short-connate and sparsely to densely yellow glandular-granulose within at the base, densely and prominently black punctate-lineate; stamens inserted at corolla tube base, the filaments basally connate to form an inconspicuous tube, the tube free from the corolla tube, the apically free portions of the filaments with scattered yellow glandular-granulose or glandular-papillate, less than half the length of the anthers, the anthers ovoid-lanceoloid, linear or lanceoloid, prominently apiculate, dehiscent by subapical pores; ovary globose, the style slender, equaling the sepals, 2—3 times longer than the ovary, the placenta apiculate, the ovules pluriseriate, biseriate, or apparently uniseriate (few in number and in a very high anthotactic spiral). **Fruit** globose or oblongoid, densely punctate and punctate-lineate, basally surrounded by persistent, clasping sepals.

Distribution.—A small distinctive subgenus of seven species with nine subspecies found from Mexico to Bolivia and adjacent Brazil.

Ecology.—Members of the subgenus occur in diverse humid to pluvial vegetation types, lowland, premontane, montane, and cloud forests.

The subgenus is defined by: 1) black, or rarely, reddish-black, punctations or punctate-lineations on all leaf and floral parts; 2) sepals often accrescent and usually clasping the developing fruit; 3) linear-lanceolate, concolorous, apiculate anthers with subapical, poricidal dehiscence; and 4) styles that are 2–3 times longer than the ovary. Among the species of *Ardisia*, it is notable that the branchlets, petioles and inflorescence rachises among species of subg. *Graphardisia* are never tomentose, but may be glabrous, puberulent, rarely hirsute or glandular-granulose. Therefore multicellular trichomes are not found in the subgenus. Species of the subgenus are often used for home decoration and for use in Christian churches for religious holidays (Pipoly, pers. obs.).

KEY TO TAXA OF *ARDISIA* SUBGENUS *GRAPHARDISIA*

1. Stoloniferous subshrubs mostly less than 1(–2) m tall; leaf blade margins sharply and irregularly dentate; corolla tube and filaments yellow glandular-granulose; Amazonian Ecuador to Bolivia and adjacent Brazil. _____ **A. weberbaueri**

1. Shrubs to small trees (0.5–)2–6(–30) m tall, without stolons; leaf blade margins entire, undulate or crenulate to serrate; corolla tube yellow glandular-granulose; filaments glabrous or sessile to stalked glandular-papillate; Mexico to the Chocó Region of Colombia.
   2. Sepals oblong, 4.2–8 mm long, apically broadly rounded to obtuse, the margins entire _____ **A. opegrapha**
      3. Inflorescence obpyramidal; leaf blades oblanceolate or rarely obovate, 3.5–7.5(–8) cm wide, 3 or more times longer than wide.
         4. Floral bracts caducous; stamens 5.2–6.5 mm long; filaments 2.5–3 mm long; sepals 5–8 mm long _____ **A. opegrapha** subsp. **opegrapha**
         4. Floral bracts persistent; stamens 3.8–5 mm long; filaments 1.5 2 mm long; sepals 4.2–5.2 mm long _____ **A. opegrapha** subsp. **wagneri**
      3. Inflorescence globose; leaf blades elliptic to broadly elliptic (7.5)8 14.5 cm wide, 2 2.5 times longer than wide _____ **A. opegrapha** subsp. **paquitensis**
   2. Sepals ovate, 1.5–3.2(–4) mm long, apically acute to rounded, tne margins subentire to entire or erose.
      5. Corolla lobes ovate, elliptic or lanceolate; filaments glabrous; Panama and Colombia _____ **A. bartlettii**
         6. Sepals 1.5 1.8 mm long; petal lobes 6–6.5 mm long; stamens 3.5– 4.8 mm long; style base tapering; tall wet forests _____ **A. bartlettii** subsp. **bartlettii**
         6. Sepals 2 2.5 mm long; petal lobes 7–8 mm long; stamens 4.5–5.7 mm long; style base stylopodic; strand vegetation and beach forests _____ **A. bartlettii** subsp. **lilacina**
      5. Corolla lobes oblong; filaments with sessile papillae to stalked-glandular-papillate; Oaxaca, Mexico to Nicaragua.
         7. Branchlets and inflorescence rachis glabrous; anthers 3–3.2 mm long _____ **A. verapazensis**
            8. Corolla lobes 6.5 6.7 mm long; free portion of filaments 3.3–3.4 mm long; style 3–3.1 mm long; fruit 6.5 -9 mm in diam.; fruiting style 7–8.6 mm long, usually only the basal portion persistent _____ **A. verapazensis** subsp. **verapazensis**
            8. Corolla lobes 5.7–5.9 mm long; free portion of filaments 2.6–2.8 mm long; style 5.5–5.9 mm long; fruit 5 6.1 mm in diam., fruiting style 8.8 9.4 mm long, the entire style usually persistent _____ **A. verapazensis** subsp. **cucullata**
         7. Branchlets and inflorescence rachis long-hirsute with reddish hairs or very sparsely to densely puberulent of simple trichomes; anthers 3.2–5.1 mm long.
            9 Branchlets very sparsely to densely puberulent _____ **3. A. tuerckheimii**
            9. Branchlets scattered to densely long hirsute with reddish hairs.
               10. Calyx lobes oblong, 3.4–3.8 mm; corolla lobes 8–8.4 mm; filaments as wide as anthers, the anthers basally hastate. _____ **2. A. verdisepala**
               10. Calyx lobes ovate, 1.9–2.7 mm; corolla lobes 4.8–8 mm; filaments abruptly constricted apically, the anthers basally subcordate __ **1. A. nigrescens**
                  11. Leaf margins crenulate or serrate; calyx lobes 1.9–2.1 mm _____ **1a. A. nigrescens** subsp. **nigrescens**
                  11. Leaf margins mostly entire to slightly crenulate or serrate; calyx lobes 2.2–2.7 mm _____ **1b. A. nigrescens** subsp. **donnellsmithii**

1. Ardisia nigrescens Oerst., Vidensk. Meddel. Dansk Naturhist. Føren

Kjøbenhavn 1861:130. 1862. *Icacorea nigrescens* (Oerst.) Standl., Contr. U.S. Natl. Herb. 23:1109. 1924. *Oerstedianthus nigrescens* (Oerst.) Lundell, Phytologia 48:142. 1981. TYPE. MEXICO. VERACRUZ: Prope Colipa, without elev., Mar 1842 (fr), *F. Liebmann 28B* (LECTOTYPE: C, here designated, F neg. # 22952, in part).

Shrubs or small trees 1–12 m tall, to 7.5 cm in diam. **Branchlets** 1–5 mm in diam., densely long hirsute reddish hairs throughout. **Leaves:** with leaf blades membranous to chartaceous, ovate or elliptic to oblong, 3.5–18.2 cm long, 1.5–8.2 cm wide, with an acumen 0.8–2.1 cm long, basally obtuse, inconspicuously to conspicuously, often prominently punctate and punctate-lineate, sparsely hispid above and below, often densely hispid along the midrib above, densely hirsute along the midrib below, the secondary veins 15–24 pairs, the margins entire or crenulate to serrate; petioles 0.5–1.6 cm long, densely hispid along above, densely hirsute below. **Inflorescences** 1.5–6 cm long, 2–8 cm wide, shorter than the leaves, the rachis with dense, long hirsute with reddish hairs, the branches 3–18-flowered corymbs; peduncles nearly absent to 1.2 cm long, densely long hirsute with reddish hairs; inflorescence branch bracts oblong to oblanceolate, 4–25 mm long, 1–14 mm wide, scattered long hirsute with reddish hairs; floral bracts similar to the inflorescence bracts but, when present, to 0.3–0.8 mm long, 0.1–0.2 mm wide; pedicels 0.7–1.4 cm long, conspicuously and prominently punctate and punctate-lineate, with densely long hirsute simple reddish hairs. **Flowers** 5–6-merous; calyx lobes ovate, 1.9–2.7 mm long, 1.1–1.5 mm wide, apically acute, sparsely hirsute outside, glandular-granules within near the base, the margins entire, densely hirsute-ciliolate; corolla 6.5–10 mm long, the tube 1.2–2.4 mm long, the lobes 4.8–8 mm long, 2.2–4.8 mm wide; stamens 4.6–6 mm long, the filaments 1.5–2.8 mm long, the staminal tube 0.5–1 mm long, the apically free portion abruptly constricted 1–2.1 mm long, the anthers 3.3–4.5 mm long, 0.8–1.1 mm wide; pistil 5–6.4 mm long, the ovary 0.8–1.2 mm long, the style 4–4.7 mm long, the ovules 5–7. **Fruits** 5.5–7.3 mm in diam.

In Oersted's (1862: p. 130) original description he cites two localities, both collected by Liebmann: "*Crescit in Mexico, ubi cl. Liebmann Martio fructificantem prope Colipa et Jecaltepec legit.*" The Museum Botanicum Hauniense (C) clearly houses the two collections used by Oersted, "Mexico, Prope Jecaltepec, Mar. 1842 (fr), *F. Liebmann 28A*" and "Mexico, Prope Colipa, Mar 1842 (fr), *F. Liebmann 28B.*" Both collections are in fruit, but the *28A* specimen has narrower leaves with no attached fruits and the *28B* specimen has wider leaves with many attached fruits. Unfortunately, the photograph taken by J.F. Macbride during the Field Museum of Natural History's project to photograph European types (F neg. no. 22952), is a combination of both specimens, although primarily of the *28B* specimens. Thus, because the *28B* specimen is more complete and more widely seen *via* the F photograph, we elect to designate the *Liebmann 28B* (C) specimen as the lectotype. Although, C.L. Lundell annotated the *28A* specimen in 1966 as the "TYPE!" he did not formally publish a lectotypification.

Within *Ardisia* subgen. *Graphardisia*, *A. nigrescens* is most closely related to *A. verdisepala*, because of the long, hirsute, with reddish tricomes throughout the vegetative parts of the plant. However, *Ardisia nigrescens* may be easily distinguished by its shorter, ovate calyx lobes (1.9–2.7 mm long), and shorter corolla lobes (4.8–8 mm long). *Ardisia verdisepala* has longer oblong calyx lobes (3.4–3.8 mm long) and longer corolla lobes (8–8.4 mm long).

1a. Ardisia nigrescens Oerst. subsp. **nigrescens (Fig. 1).**

Shrub or small tree 1.5–5 m tall. **Branchlet** slender, terete, 1–3 mm in diam., with dense, long hirsute simple reddish hairs throughout. **Leaves:** with leaf blades membranous, elliptic, 3.5–11.2 cm long, 1.5–5.2 cm wide, apically abruptly acuminate, the acumen 0.8–1.4 cm long, basally obtuse, midrib impressed above, prominently raised below, the secondary veins 15–24 pairs, prominulous above, prominently raised below, inconspicuously to conspicuously, often prominently punctate and punctate-lineate, sparsely hispid above and below, often densely hispid along the midrib above, densely hirsute along the midrib below, the margins crenate to serrate, flat; petioles slender, canaliculate, 0.5–1.1 cm long, densely hispid along above, densely hirsute below. **Inflorescence** terminal, rarely lateral, erect, pinnate paniculate, 1.5–5 cm long, 2–5.5 cm wide, shorter than the leaves, the rachis with dense, long hirsute simple reddish hairs, the branches 3–7 flowered corymbs; peduncles nearly absent to 1 cm long, with dense, long hirsute simple reddish hairs; inflorescence branch bracts caducous, membranous, oblong to oblanceolate, 2–2.5 cm long, 0.1–0.4 cm wide, apically acute, basally acute on sessile or short petioles, the veins prominent, conspicuously and prominently punctate and punctate-lineate, with scattered, long hirsute, simple reddish hairs, the margins entire; floral bracts similar to the inflorescence bracts but, 0.3–0.8 mm long, 0.1–0.2 mm wide; pedicels slender, terete, 0.7–1.4 cm long, conspicuously and prominently punctate and punctate-lineate, with dense, long hirsute simple reddish hairs. **Flowers** 5–6-merous, white to pink; calyx lobes membranous, ovate to narrow ovate, 1.9–2.1 mm long, 1.1–1.3 mm wide, apically acute, conspicuously and prominently punctate and punctate-lineate, sparsely hirsute outside, granular-glandules within near the base, the margins entire, densely hirsute-ciliolate; corolla membranous, 6.5–10 mm long, the tube 1.2–2.4 mm long, the lobes oblong, 4.8–8 mm long, 2.2–4.8 mm wide, apically acute to rounded, conspicuously and prominently punctate and punctate-lineate, glabrous except with scattered yellow papillae at the base within, the margins entire, erose; stamens 5–6 mm long, the filaments 1.9–2.8 mm long, the staminal tube 0.5–1 mm long, the apically free portions abruptly constricted, 1.3–2.1 mm long, epunctate, with scattered yellow papillae near the base, the anthers free, lanceolate, 3.5–4.4 mm long, 0.9–1.1 mm wide, apically apiculate, basally subcordate, the connective inconspicuously punctate; pistil 5–5.5 mm long, glabrous, inconspicuously punctate, the ovary ovate, 0.8–1.1 mm long, the style 4–

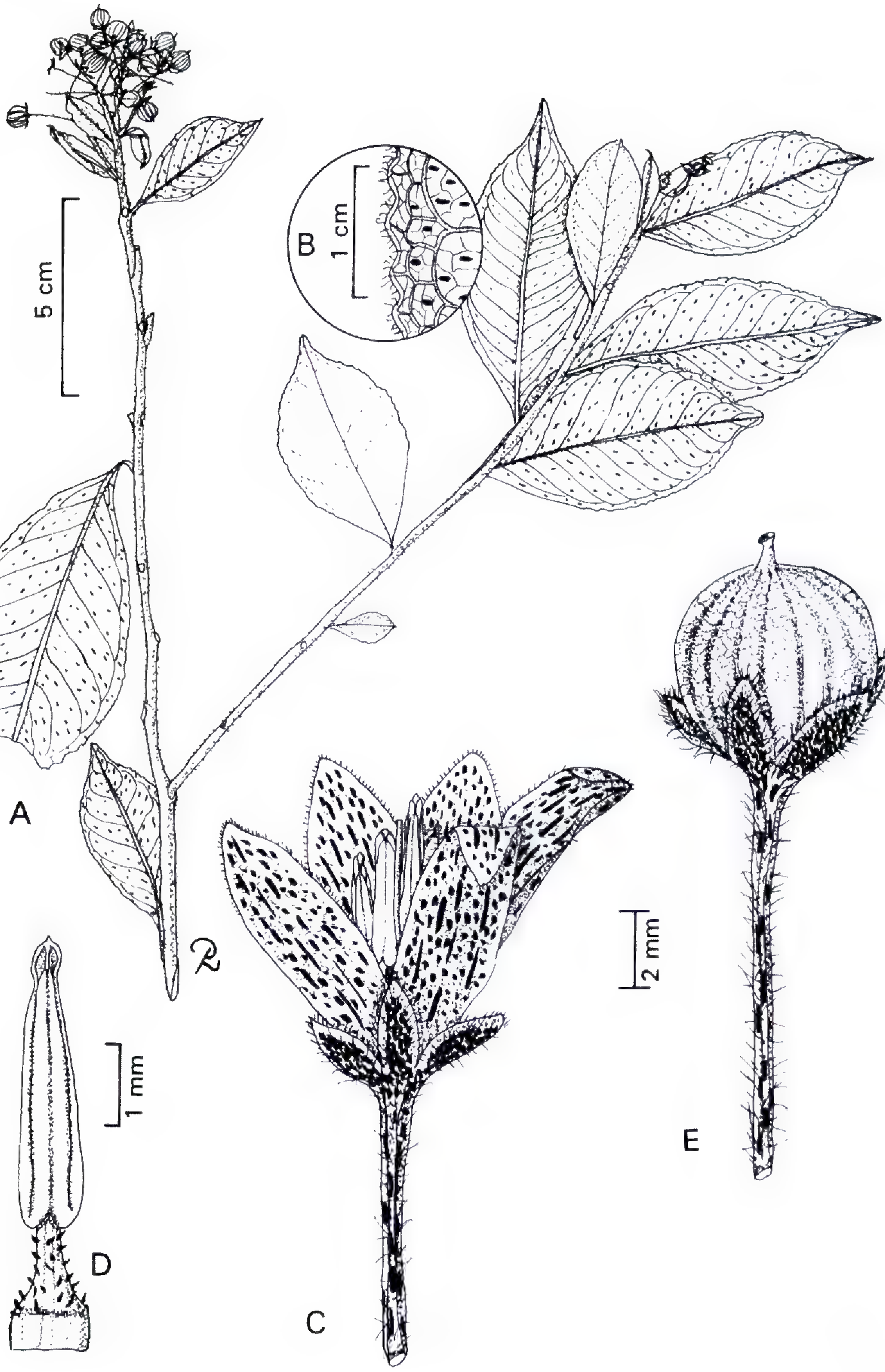


FIG. 1. *Ardisia nigrescens* Oerst. subsp. *nigrescens* **A.** Flowering branch. **B.** Detail of abaxial leaf surface. **C.** Flower. **D.** Stamen, showing adaxial surface. **E.** Fruit. A–B, E drawn from lectotype, *F. Liebmann 28B* (C). C & D drawn from *H. Hernández & R. Torres 813* (MO).

4.4 mm long, stylipodic, inconspicuously punctate and punctate-lineate, the ovules 5–7. **Fruit** globose to oblong, 6.9–7.3 mm long, 6.2–6.6 mm in diam., inconspicuously punctate and punctate-lineate.

Distribution.—*Ardisia nigrescens* subsp. *nigrescens* is known from Mexico (Puebla, San Luis Potosí, Oaxaca, Veracruz, Chiapas and Tabasco) and in Nicaragua (Jinotega and Zelaya). It grows at 50–1000 m elevation.

Ecology and conservation status.—Subsp. *nigrescens* occurs in primary deciduous and evergreen, lower montane rain forests. This subspecies does not appear to be threatened.

Etymology.—The epithet is based on the latin 'niger' or 'nigrescens' meaning 'becoming black' and refers to the black hispid trichomes.

Ardisia nigrescens subsp. *nigrescens* is most closely related to subsp. *donnellsmithii* because they have similar reddish, hirsute trichomes and ovate calyx lobes. However, subsp. *nigrescens* has crenulate or serrate leaf margins and shorter calyx lobes (1.9–2.1 mm long), whereas subsp. *donnellsmithii* has mostly entire to slightly crenulate or serrate leaf margins and longer calyx lobes (2.2–2.7 mm long).

Specimens examined: **MEXICO. Chiapas:** Mpio. Ocosingo, Laguna Ocotal Grande, 3,300 ft [1,006 m], 14 Apr 1967 (fr), *D. Breedlove 15702* (F, LL); Mpio. Palenque, 6–12 km S of Palenque on the road to Ocosingo, 300 m, 22 Feb 1972 (fr), *D. Breedlove 24232* (F, LL, MO, NY); Mpio. La Libertad, 15–20 km towards Chancala on road to Bonompak from the Palenque-Ocosingo road, 280 m, 4 Jan 1981 (fl), *D. Breedlove 49112* (GH, MO, NY, TEX); Mpio. La Libertad, 10 km towards Chancala on road to Bonompak from the Palenque-Ocosingo road, 280 m, 16 Jan 1982 (fl), *D. Breedlove & E. Almeda 57370* (DUKE, LL, MO, NY, TEX); Mpio. Ocosingo, near Laguna Ocotal Grande, ca 25–30 km SE of Monte (Cerro) Libano, ca. 950 m, 26 Jul 1954 (fl), *R. Dressler 1507* (GH); Mpio. Palenque, a lo largo del Río Nututún, ca. 1 km río abajo de la carretera, without elev., 14 Jan 1985 (fl), *H. Hernández & R. Torres 813* (FTG, LL, MEXU, MO); Mpio. San Cristóbal de Las Casas, Santa Cruz en San Filipe, without elev., 15 Nov 1986 (fl), *A Mendez E. & M. Concepción Mtz. de López 9499* (GH, MO, NY, TEX). **Oaxaca:** Ejido Roberto Colorado, near Tuxtepec, without elev., 9 Dec 1943 (fl-bud), *E. Hernández X. 102* (LL); District Tuxtepec, Chiltepec and vicinity, ca. 20 m, Jul 1940–Feb 1941 (ster.), *G. Martínez-Calderón 209* (LL); ca. 200 m, 20 Nov 1941 (fr), *G. Martínez Calderón 828* (GH). **Puebla:** Bosque Ajenjelre, without elev, Aug 1951 (fr), *D. Ramirez C. s.n.* (MEXU); Mpio. Hueytamalco, Paxta, 250 m, 4 Nov 1983 (fr), *F. Ventura A. 20767* (MEXU, MO). **San Luis Potosí:** Mpio. San Antonio, Lejem, without elev., 1 May 1979 (fr), *J. Alcorn 2937* (TEX 2 sheets); Mpio. Tamazunchale, Tamazunchale, 200 m, Jul 1937 (fr), *C. Lundell & A. Lundell 7130* (LL). **Tabasco:** Mpio. Tacatalpa, Cerro del Madrigal, km 7 de la E Tacotalpa hacia Tapijulapa, without elev., 17 Jun 1983 (fr), *C. Cowan et al. 3935* (TEX-2 sheets), S side of Mex. Hwy. 186, 2.2 mi W of Tabasco-Chiapas border, ca. 33 mi E of Macuspana, without elev., 23 Dec 1973 (fl), *A. Reznicek et al. 187* (MICH). **Veracruz:** 34 km de Tantoyuca, hacia Tuxpan, 280 m, 12 Nov 1970 (fl), *F. Chiang 301* (F, GH); 20 km de Tepetzintla, hacia Tantoyuca, without elev., 18 Mar 1971 (fr), *F. Chiang 377* (F, GH, MEXU); 20 km al N de Martínez de La Torre, without elev., 2 May 1963 (fr), *A. Gómez P. 7885* (LL); Jecaltepec, without elev., Mar 1841 (fr), *F. Liebmann 28A* (C-lectoparatype); Mpio. Puente Nacional, Barranca de Palmillas, 2 km al SE de dicha población, 19° 12' N, 096° 45' W, 450 m, 24 Jul 1985 (fr), *M. Medina A. & F. Vázquez B. 379* (F); Mpio. Misantla, Cerro Espaldilla, an old isolated volcanic plug ca. 5 km N of Miscantla, 19° 58' N, 096° 50' W, 400 m, 14 Jun 1986 (fr), *G. Schatz et al. 1195* (NY, US); Without locality, without elev., without date (fr), *L. Schnée & P. Maury s.n.* (P-2 sheets); 6 mi N of Tuxpan on Hwy. 165, without elev., 2 Jan 1959 (fl), *B. Thompson & B. Fields 379* (TEX); Mpio. Martínez de la Torre, El Mirador, 100 m, 16

Nov 1976 (fl, fr), *F. Ventura A. 13621* (MEXU, MO). **Without further locality in Mexico:** Without locality, without elev., 1865–1866 (fr), *M. Hahn 21* (K); San Pablo, without elev., Jun 1841 (fr), *F. Liebmann 15341* (F); Without locality, without elev., 1841–1842 (fr), *W. Karwinsky 450* (H); 1787–1804 (fl), *M. Sessé et al. 679* (F, F neg. no. 47119); *730* (F, F neg. no.47121). **NICARAGUA. Jinotega:** Cerro San Pedro, Comarca Kilambe, 13° 36' N, 085° 38–39' W, 820 m, 21 Jul 1980 (fl), *J. Sandino 181* (MO). **Zelaya:** 20 km NW de Alamicamba, 13° 36' N, 084° 22' W, 50 m, 16 Apr 1971 (fr), *E. Little 25392* (MO, US).

1b. Ardisia nigrescens Oerst. subsp. **donnellsmithii** (Mez) Ricketson & Pipoly, comb. et stat. nov. **(Fig. 2).** *Ardisia donnellsmithii* Mez, Bull. Herb. Boiss. ser. II, 3:235. 1903. *Ardisia nigrescens* Oerst. var. *donnellsmithii* (Mez) Lundell, Wrightia 3:99. 1964. *Oerstedianthus donnellsmithii* (Mez) Lundell, Phytologia 48:141. 1981. *Ardisia multilineata* Mez, Repert. Spec. Nov. Regni. Veg. 16:311. 1920, nom. superfl. TYPE. GUATEMALA. ALTA VERAPAZ: Cubilquitz, 350 m, Sep 1900 (fl), *H. von Türckheim 7766* (HOLOTYPE: B-destroyed; LECTOTYPE: here designated, US; ISOLECTOTYPES: GH, LL, F neg. no. 55603).

Shrub or small tree 0.9–6–(12) m tall, 2.5–7.5 cm in diam. **Branchlets** slender, terete, 2–5 mm in diam., with dense, long hirsute simple reddish hairs throughout. **Leaves:** with leaf blades membranous to chartaceous, ovate or elliptic to oblong, 5–18.2 cm long, 2.1–8.2 cm wide, apically abruptly acuminate, the acumen 1.2–2.1 cm long, basally obtuse, the midrib impressed above, prominently raised below, the secondary veins 15–24 pairs, prominulous above, prominently raised below, inconspicuously to conspicuously, often prominently punctate and punctate-lineate, sparsely hispid above and below, often densely hispid along the midrib above, densely hirsute along the midrib below, the margins mostly entire or slightly crenate to slightly serrate, flat; petioles slender, canaliculate, 0.6–1.6 cm long, densely hispid along above, densely hirsute below. **Inflorescences** terminal, rarely lateral, erect, pinnately paniculate, 3–6 cm long, 4–8 cm wide, shorter than the leaves, the rachis with dense, long hirsute, simple reddish hairs, the branches 14–18 flowered corymbs; peduncles nearly absent to 1.2 cm long, with dense, long hirsute, simple reddish hairs; inflorescence branch bracts caducous, membranous, oblong to oblanceolate, 0.4–2.5 cm long, 0.1–1.4 cm wide, apically acute, basally acute on sessile or short petioles, the veins prominent, conspicuously and prominently punctate and punctate-lineate, with scattered, long hirsute, simple reddish hairs, the margins entire; floral bracts apparently absent, with no apparent scars; pedicels slender, terete, 0.7–1.3 cm long, conspicuously and prominently punctate and punctate-lineate, with dense, long hirsute, simple reddish hairs. **Flowers** 5-merous, white to pink; calyx lobes membranous, ovate, 2.2–2.7 mm long, 1.2–1.5 mm wide, apically acute, conspicuously and prominently punctate and punctate-lineate, sparsely hirsute outside, granular-glandules within near the base, the margins entire, densely hirsute-ciliolate; corolla membranous, 7.8–8.7 mm long, the tube 1.6–2 mm long, the lobes oblong, 6.3–7.5 mm long, 2.8–3.3 mm wide, apically acute to rounded, conspicuously and prominently punctate and punctate-lineate, glabrous except with scattered yellow papillae at the base within, the

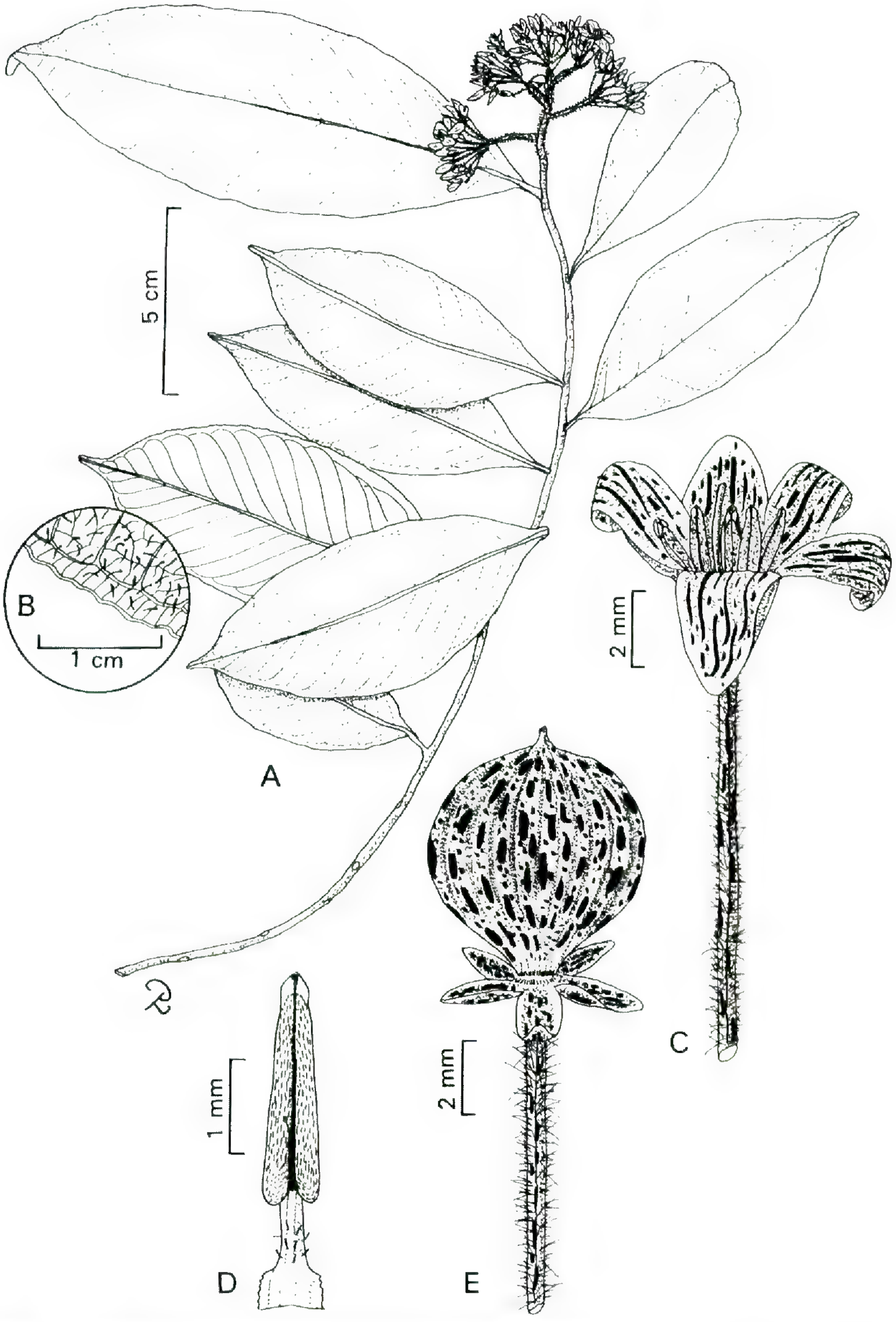


FIG. 2. *Ardisia nigrescens* Oerst. subsp. *donnellsmithii* (Mez) Ricketson & Pipoly. **A.** Flowering branch. **B.** Detail of abaxial leaf surface. **C.** Flower. **D.** Stamen, showing adaxial surface. **E.** Fruit. A–D drawn from lectotype, *H. von Türckheim 7766* (US). E drawn from *G. Davidse & A. Brant 32362* (MO).

margins entire, erose; stamens 4.6–5.5 mm long, the filaments 1.5–2 mm long, the staminal tube 0.5–0.7 mm long, the apically free portions abruptly constricted, 1–1.5 mm long, epunctate, with scattered yellow papillae near the base, the anthers free, lanceolate, 3.3–4.5 mm long, 0.8–1.1 mm wide, apically apiculate, basally subcordate, the connective inconspicuously punctate; pistil 5.4–6.4 mm long, glabrous, inconspicuously punctate, the ovary ovate, 0.8–1.2 mm long, the style 4–4.7 mm long, inconspicuously punctate and punctate-lineate, the ovules 12–15. **Fruit** globose, 5.5–7.2 mm long, 6.2–6.6 mm in diam., inconspicuously punctate and punctate-lineate.

Distribution.—*Ardisia nigrescens* subsp. *donnellsmithii* is known from Mexico (Chiapas), Belize (Stann Creek and Toledo) and Guatemala (Alta Verapaz, Huehuetenango and Petén). It grows from 50–950 m.

Ecology and conservation status.—Subsp. *donnellsmithii* occurs in lower montane rain forest.

Etymology.–This taxon was dedicated to John Donnell Smith (1829–1928), who collected extensively in Guatemala and Central America.

In Mez's (1903) original description he lists two collections by *H. von Türckheim* numbers *7766* and *7918*, both in the Mez Herbarium (B). These original collections were destroyed in 1943 during WWII, necessitating the need to select a lectotype. Although, C.L. Lundell labeled the US sheet of *H. von Türckheim 7766* as the "Holotype," he failed to actually publish a lectotypification of the collection. However, from the available material, the US sheet is the best material, and we here select it as the lectotype for this taxon. The only known sheet of *H. von Türckheim 7918* is also at US but is missing the inflorescence and has only a few loose fruits. Unfortunately, Mez (1920) re-described this same material as *Ardisia multilineata* using the same *H. von Türckheim* collections, thus making this name superfluous.

Specimens examined. **MEXICO. Chiapas:** Mpio. Ocozocoautla, 46 km N of Ocozocoautla on road to Mal Paso, 700 m, 8 Oct 1974 (fr), *D. Breedlove 38709* (DS, LL-2 sheets); Mpio. Palenque, 50 km SW of Palenque on road to Ocosingo near Colonia Úrsulo Galvano, 370 m, 9 Nov 1980 (fr), *D. Breedlove 47348* (CAS); Mpio. La Libertad, 15–20 km towards Chancala on road to Bonampak from the Palenque-Ocosingo road, 280 m, 4 Jan 1981 (fr), *D. Breedlove 49160* (LL, NY); Mpio. Ocosingo, on ridges near lake at Naja, 300 m, 3 Mar 1981 (fr), *D. Breedlove 49970* (LL, MO, NY); Mpio. Chilón, near and along road to Pozo Cuevas above Agua Azul, 600 m, 14 Jan 1982 (fr), *D. Breedlove & F. Almeda 57228* (LL, MO); Mpio., La Independencia, ridges 45–50 km E of Lagos de Montebello National Park on road to Ixcán from Santa Elena, 760 m, 22 Jan 1982 (f), *D. Breedlove 57759* (CAS); Mpio. Ocosingo, S of Santo Domingo on road to Bonampak and Echeverría from Chancala, 455 m, 25 Jan 1982 (fr), *D. Breedlove & F. Almeda 57927* (MO); Mpio. Ocosingo, near Laguna Ocotal Grande, ca. 25–30 km SE of Monte (Cerro) Líbano, ca. 950 m, 10 Aug 1954 (fl), *R. Dressler 1637* (GH, US); Río Salinas, without elev., 8 Feb 1964 (fl), *C. Lundell 17823* (LL); Mpio. Ocosingo, Bonampak, 350 m, 12 Jun 1984 (fr), *E. Martínez S. 6523* (MO); *6537* (MO); Mpio., 4 km W of Crucero Corozal along Palenque road, Boca Lacantum, 180 m, 10 Aug 1984 (fr), *E. Martínez S. 6901* (MEXU); 19 Sep 1984 (fl), *E. Martínez S. 7622* (MO, TEX); Mpio. Ocosingo, Sierra la Cojolite, 8 km W of Crucero Corozal 7 km E of Bonampak, 540 m, 20 Sep 1984 (fl), *E. Martínez S. 7658* (MEXU); Mpio. Ocosingo, 10 km SE of Crucero Corozal, road to Boca

Lacantum, 200 m, 18 Aug 1984 (fl), *E. Martínez S. 7411* (FTG, MO); Mpio. Ocosingo, near Marqués of Comillas, 6 km SE of Ejido Benemérito de las Americas, toward Flor de Cacao, 160 m, 8 Oct 1984 (fr), *E. Martínez S. 8059* (MO); Mpio. Ocosingo, 6 km S of Campamento COFOLASA, and 24 km SE of Crucero Corozal, Palenque-Boca Lacantum road, 200 m, 17 Oct 1984 (fl), *E. Martínez S. 8427* (MO); Mpio. Ocosingo, 5 km S of Crucero Corozal, on road to Boca Lacantum, 250 m, 22 Oct 1984 (fl), *E. Martínez S. & G. Aguilar 8630* (MO); Mpio. Ocosingo, Boca Lacantum, 120 m, 28 Oct 1984 (fr), *E. Martínez S. & G. Aguilar 8790* (MO); Mpio. Ocosingo, Campamento COFOLASA 24 km SE of El Crucero Corozal, on Palenque-Boca Lacantum road, 220 m, 7 Dec 1984 (fl), *E. Martínez S. 9318* (MO); Mpio. Ocosingo, 10 km S of Ejido Benemérito de Las Americas, road to Flor de Cacao, Zona Marquez de Comillas, 120 m, 9 Dec 1984 (fl), *E. Martínez S. 9361* (MO); Mpio. Ocosingo, Boca Lacantum, along Río Lacantum, 120 m, 10 Dec 1984 (fr), *E. Martínez S. 9581* (MEXU); Mpio. Ocosingo, 2 km W of Crucero Corozal, Palenque-Boca Lacantum road, 180 m, 13 Feb 1985 (fr), *E. Martínez S. 10106* (MO, TEX); *10132* (MO); 22 Feb 1985 (fr), *E. Martínez S. 11075* (MEXU); Mpio. Ocosingo, Crucero Corozal, 180 m, 5 Apr 1985 (fr), *E. Martínez S. 11531* (MEXU); Mpio. Ocosingo, 19 km NW of Crucero Corozal, road to Palenque, 600 m, 8 Sep 1985 (fl), *E. Martínez S. 13454* (MO, TEX); Mpio. Ocosingo, a 3 km NW of Vertice del Chixoy road a Boca Lacantum, 120 m, 11 Sep 1985 (fr), *E. Martínez S. 13616* (MO); Mpio. Ocosingo, 15 km NW of Boca Lacantum, road to Palenque, 220 m, 13 Sep 1985 (fr), *E. Martínez S. & G. Aguilar 13707* (MO); Mpio. Ocosingo, Neuvo Veracruz, 33 km W of Vertice del Río Chixoy, road to Chajul, Marquéz de Comillas, 130 m, 10 Jan 1986 (fr), *E. Martínez S. 15982* (MEXU); Mpio. Ocosingo, 2 km N of Naja, road to Chancala, 900 m, 24 May 1987 (fr), *E. Martínez S. 21333* (MO); Mpio. Ocosingo, 2 km S of Naja, 16° 58' N, 091° 36' W, 940 m, 24 Sep 1988 (fl, fr), *W. Stevens & E. Martínez S. 25849* (FTG, MO); Mpio. Ocosingo, near Chamisal, 760 m, 3 Dec 1976 (fl), *P. Valdivia Q. 2407* (LL, MO). **BELIZE. Stann Creek:** Middlesex, without elev., 25 May 1939 (fr), *P. Gentle 2798* (A, F, MO, NY, US); 200 ft [61 m], 24 Jul 1929 (fr), *W. Schipp 287* (A, F, GH, MO, NY), 23 Nov 1929 (fl), *W. Schipp 478* (A, BM, F, G, GH, K, MO, NY, TEX); 1928 (fr), *N. Stevenson V* (US). **Toledo:** Maya Mountains, canyon along Bladen Branch from Richardson Creek to Quebrada de Oro, 16° 31–33' N, 088° 46–49' W, 100–200 m, 12 Mar 1987 (fr), *G. Davidse & A. Brant 32362* (BRH, F, FTG, LL, MO); Maya Mountains, Bladen Nature Reserve, Ek Xux canyon, 1.8 airline km NW of the Ek Xux archeological site, 16° 30' 57" N, 088° 55' 10" W, 320 m, 18 May 1996 (fr), *G. Davidse 36051* (BRH, MO, SEL); Balo Camp, upper reach of Golden Stream, without elev., 12 Apr 1944 (fr), *P. Gentle 4522* (LL-2 sheets); Jacinto Creek, Río Grande, without elev., 18 Oct 1944 (fl), *P. Gentle 4895* (LL- 2 sheets); Temash River, without elev., 27 Feb 1945 (fr), *P. Gentle 5231* (LL-2 sheets, PH, TEX); Ridge beyond Columbia, without elev., 25 Feb 1947 (fr), *P. Gentle 6177* (LL-2 sheets, TEX); Feeders Road, 14 Miles, San Antonio-Punta Gorda Road, without elev., 5 May 1949 (fr), *P. Gentle 6729* (LL-3 sheets); Cero, without elev., 15 Feb 1950 (fr), *P. Gentle 6980* (LL-2 sheets, TEX); Between Orange Point and Moho River, without elev., 7 Apr 1952 (fr), *P. Gentle 7639* (F, LL-2 sheets, US); Camp 3, 6–8 km SE of Union Camp, trail from Camp 3 toward the Jimmy cut trail, 16° 23' 14" N, 089° 04' 37" W, 665–700 m, 16 Feb 1997 (fr), *T. Hawkins 1443A* (MO); Toledo, without elev., 10 Nov 1906 (fl), *M. Peck 576* (GH, K, NY); Forest Home, 200 ft [61 m], 2 Nov 1933 (fl), *W. Schipp 482* (F, MO). **GUATEMALA. Alta Verapaz:** Sebol, ca. 6 km from village near Rubelquiche, without elev., 13 Apr 1964 (fr), *E. Contreras 4254* (LL-2 sheets, TEX); Sebol, on old Petén road, without elev., 14 Apr 1964 (fr), *E. Contreras 4291* (GH, LL-2 sheets, TEX); Sebol, without elev., May 1964 (fr), *E. Contreras 4667* (LL); Sebol and vicinity, without elev., Jul 1964 (fl), *E. Contreras 5414* (LL-3 sheets); Near Finca Sepacuite, near Cajabón, without elev., 26 Apr 1902 (fr), *O. Cook & R. Griggs 767* (US); Semacoch, without elev., 8 Mar 1905 (fr), *G. Goll 261* (US); Xalavé, 1,500 ft [457 m], 25 Jun 1920 (fl), *H. Johnson 228* (A, F, US); Forest in valley, "pantano," 2.5 mi W of Cubilgüitz, 250–300 m, 28 Feb 1942 (fr), *J. Steyermark 44284* (F); *44322* (F); 1.5–2 mi S of Cubilgüitz, 300–350 m, 1 Mar 1942 (fr), *J. Steyermark 44383* (F, US); S side of Cerro Chinajá, between Sachaj and Sacacac, 150–180 m, 20 Mar 1942 (fr), *J. Steyermark 45161* (F); Cubilqüitz, 350 m, Dec 1900 (fr), *H. von Tuerckheim 7918* (US isolectotype); Aug 1904 (fl), *H. von Tuerckheim 8707 [II978]* (US-3 sheets); Oct 1906 (fl), *H. von Tuerckheim II163* (BR-2 sheets, F, G-3 sheets, LL, MO). **Huehuetenango:** Between Ixcan & Rio Ixcan, Sierra de los Cuchumatanes, 150–200 m, 23 Jul 1942

(fr), *J. Steyermark 49253* (F). **Petén:** La Cumbre, without elev., 30 Sep 1966 (fr), *E. Contreras 6290* (LL-2 sheets, TEX); La Cumbre, bordering Río Chacte, E of km 135, without elev., 19 Jul 1976 (fr), *E. Contreras & C. Lundell 20069* (LL-2 sheets); Sayaxche, around airport, without elev., 9 Feb 1964 (fr), *C. Lundell 17923* (LL); Sayaxche, on Arroyo Santa Cruz trail, without elev., 11 Feb 1964 (fl), *C. Lundell 17978* (LL); Sayaxche, in cañada 2 km NE of village on Santa Cruz trail, without elev., Feb 1964 (fr), *C. Lundell 18039* (LL); (fl), *C. Lundell 18040* (LL-2 sheets, TEX); Laguna Petexbatun, forest bordering the lake, without elev., 2 Apr 1964 (fr), *C. Lundell 18133* (LL-2 sheets); Between Finca Yalpemech & Chinajá, 50–100 m, 28 Mar 1942 (fr), *J. Steyermark 45427* (F, US); W & NW of Chinajá, between Río Chinajá & 6 mi W of Río San Ramán, 50–70 m, 29 Mar 1942 (fl), *J. Steyermark 45493* (F).

2. Ardisia verdisepala Ricketson & Pipoly, sp. nov. **(Fig. 3)**. TYPE. MEXICO. CHIAPAS: Mpio. Ocosingo, 15 km SW of Ocosingo on road to San Cristóbal Las Casas, 1,372 m, 1 Sep 1981 (fl), *D. Breedlove 52591* (HOLOTYPE: MO; ISOTYPES: CAS, GH, LL, NY).

Propter ramulosque rhachides inflorescentiarum longi-hirsutos A. nigrescens valde arcte affinis sed ab ea lobis calycinis oblongisque (non ovatisque) 3.4–3.8 (nec 1.9–2.7) mm longis praeclare distat.

Shrub to small tree 1.2–6.1 m tall. **Branchlets** slender, terete, 1–2.5 mm in diam., with dense, long hirsute simple reddish hairs throughout. **Leaves:** with leaf blades, membranous, elliptic to oblong, 3.3–10.2 cm long, 1.5–4.8 cm wide, apically abruptly acuminate, the acumen 0.5–1.6 cm long, basally acute to obtuse, the midrib impressed above, prominently raised below, the secondary veins 12–19 pairs, prominulous above, prominently raised below, conspicuously and prominently punctate and punctate-lineate, sparsely hispid above and below, often densely hispid along the midrib above, densely hirsute along the midrib below, the margins serrate, flat; petioles slender, canaliculate, 3.5–8 mm long, with dense, long hispid reddish hairs above and below. **Inflorescences** terminal, rarely lateral, erect, pinnately paniculate, 3–6 cm long, 3–6.5 cm wide, shorter than the leaves, the rachis with dense, long hirsute, simple reddish hairs, the branches 5–7 flowered corymbs; peduncles nearly absent to 1.5 cm long, with dense, long hirsute, simple reddish hairs; inflorescence branch bracts caducous, membranous, oblong to obovate or oblanceolate, 7.5–15.5 mm long, 3.5–6 mm wide, apically acute, basally acute on sessile or short petioles, the veins prominent, conspicuously and prominently punctate and punctate-lineate, with scattered to dense, long hirsute, simple reddish hairs, the margins entire; floral bracts apparently absent above, with no apparent scars, below similar to the inflorescence branch bracts but, early caducous, usually linear, 3.8–6.6 mm long, 1.3–1.5 mm wide; pedicels slender, terete, 1.5–2.5 cm long, conspicuously and prominently punctate and punctate-lineate, with dense, long hirsute, simple reddish hairs. **Flowers** 5-merous, white to pink or reddish; calyx lobes membranous, narrowly oblong, 3.4–3.8 mm long, 1.2–1.7 mm wide, apically acute to rounded, conspicuously and prominently punctate and punctate-lineate, sparsely hirsute outside, glabrous within, the margins entire, scattered hirsute-ciliolate; corolla membranous, 9.2–9.8 mm long, the tube 1.2–1.4 mm long, the lobes oblong, 8–8.4 mm long, 3.2–5.4 mm wide, apically acute to rounded, conspicuously and prominently punctate and punctate-lineate, glabrous except with

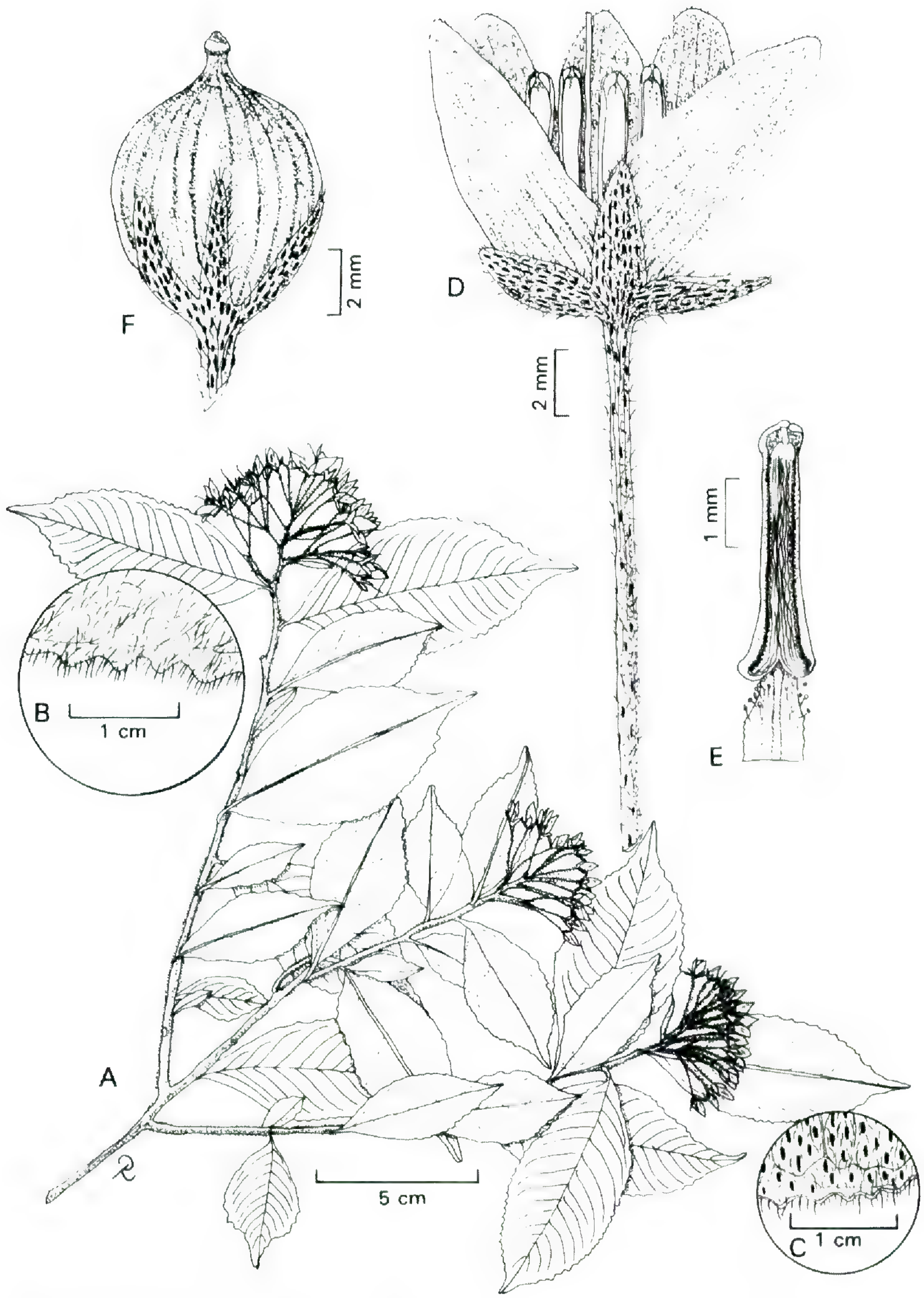


FIG. 3. *Ardisia verdisepala* Ricketson & Pipoly. **A.** Flowering branch. **B.** Detail of adaxial leaf surface. **C.** Detail of abaxial leaf surface. **D.** Flower. **E.** Stamen, showing adaxial surface. **F.** Fruit. A–D drawn from holotype, *D. Breedlove 52591* (MO). F drawn from *A. Méndez Ton 5667* (MO).

scattered yellow papillae at the base within, the margins entire, erose; stamens 5–5.8 mm long, the filaments 1.7–2.2 mm long, the staminal tube 0.5–0.7 mm long, the apically free portions as wide as the anthers, 1.4–1.7 mm long, epunctate, with scattered yellow papillae near the base, the anthers free, lanceolate, 3.8–4.3 mm long, 1–1.2 mm wide, apically apiculate, basally hastate, the connective inconspicuously punctate; pistil 5.5–6.8 mm long, glabrous, inconspicuously punctate, the ovary ovate, 1–1.5 mm long, the style 4.5–5.6 mm long, inconspicuously punctate and punctate-lineate, the ovules 14–17. **Fruit** globose, 5.4–7 mm long, inconspicuously punctate and punctate-lineate.

Distribution.—*Ardisia verdisepala* is endemic to the area around Ocosingo, Chiapas, Mexico. It grows from 550–1,372 m.

Ecology and conservation status.—*Ardisia verdisepala* occurs in evergreen pine-oak, lower montane and montane rain forests. Although, no specimens have been collected since the 1980s, it seems to be locally common and not presently threatened.

Etymology.—The epithat *verdisepala* comes from the greenish color of the sepals, which is evident because of the reduced number of punctations on the calyx lobes.

Ardisia verdisepala has affinities to *A. nigrescens* because of the similar vestiture, but is easily separated by the narrowly oblong calyx lobes verses the ovate lobes of *A. nigrescens*. *Ardisia verdisepala* also has affinities to *A. tuerkheimii*, because both have narrow calyx lobes; however, *A. verdisepala* is immediately separated from the virtually glabrous *A. tuerckheimii*, by the well-developed vestiture.

PARATYPES. **MEXICO. Chiapas:** Mpio. Ocosingo, 6–8 km N of Ocosingo along road to Bachajón, 900 m, 9 Nov 1971 (fl), *D. Breedlove & A. Smith 22120* (MO); *22121* (LL, MO, NY); 24 Sep 1972 (fl), *D. Breedlove 27927* (LL, MO, NY); Mpio. Ocosingo, adjacent to Laguna Ocotal Grande, 800 m, 6 Feb 1973 (fr), *D. Breedlove 33006* (LL, MO); Mpio. Bachajón, 3 km N Bachajón-Ocosingo road on road to Palenque, 1,170 m, 13 Jan 1981 (fr), *D. Breedlove 49445* (CAS, DUKE, LL, MO, NY, TEX); Mpio. Ocosingo, 70 km SW of Palenque on road to Ocosingo along the Jol Uk'um, 550 m, 14 Jan 1981 (fl), *D. Breedlove & B. Keller 49485* (DUKE, LL, MO, NY, TEX); Mpio. Bachajón, 3 km N of Bachajón-Ocosingo road at Temo on road to Palenque, 1,170 m, 31 Aug 1981 (fl), *D. Breedlove 52487* (CAS, DUKE, F, LL, MO, NY); Mpio. Ocosingo, 80 km SW of Palenque on road to Ocosingo along the Jol Uk'um, 760 m, 14 Jan 1982 (fl), *D. Breedlove & F. Almeda 57210* (CAS, GH, LL, MO, NY); Mpio. Yajalón, K'ak'ate'el, 1,100 m, 15 Jul 1982 (fr), *A. Méndez G. 4445* (MEXU, MO); Mpio. Oxchuc, La Cascada de Mesbija, 1,300 m, 29 Nov 1982 (fl), *A. Méndez T. 5097* (MEXU, MO); Mpio. Yalalón, Rancho San Luis, 1,000 m, 10 Feb 1983 (fr), *A. Méndez T. 5469* (ASU, MEXU, MO, TEX); Mpio. Yajalón, Banco de grava, 1,000 m, 10 Mar 1983 (fr), *A. Méndez T. 5640* (MEXU, MO, TEX); Mpio. Yajalón, Rancho San Luís, 900 m, 15 Mar 1983 (fr), *A. Méndez T. 5667* (MEXU, MO, TEX); 15 Apr 1983 (fr), *A. Méndez T. 5837* (MEXU, MO); 15 Apr 1983 (fr), *A. Méndez T. 5842* (MEXU, MO); Mpio. Yajalón, Arroyo en la Graba, 800 m, 16 May 1983 (fr), *A. Méndez T. 6052* (MEXU, MO, TEX); Mpio. Sabanilla, Finca Morelia, 650 m, 5 Jun 1983 (fr), *A. Méndez T. 6112* (MEXU, MO, TEX); Mpio. Yajalón, El Azufre, 700 m, 20 Jun 1983 (fr), *A. Méndez T. 6211* (MEXU, MO, TEX).

3. Ardisia tuerckheimii Donn. Sm., Bot. Gaz. 13:74. 1888. **(Fig. 4).** *Oerstedianthus tuerckheimii* (Donn. Sm.) Lundell, Phytologia 48:142. 1981. TYPE. GUATEMALA.

ALTA VERAPAZ: Pansamalá, mountain forests, 3,800 ft [1,158 m], Aug 1886 (fl), *H. von Türckheim 1035* (LECTOTYPE: US sheet no. 40099, here designated, US neg. no. 2390; ISOLECTOTYPES: F (F neg. no. 68257), G-4 sheets, GH-2 sheets, K, LL (F neg. no. 55673), M, MO (LL neg. no. 71-116), NY-2 sheets, PH, US sheet no. 1339942 (US neg. no. 2391)).

Ardisia mitchellae I.M. Johnst., Contr. Gray Herb. 81:96. 1928. *Oerstedianthus mitchellae* (I.M. Johnst.) Lundell, Phytologia 48:142. 1981. TYPE. HONDURAS. ATLÁNTIDA: vicinity of Tela, near a river, 50 ft. [15 m], 4 Apr 1926 (fl), *E. Mitchell 66* (HOLOTYPE: GH; ISOTYPE: US).

Ardisia carlsonae Steyerm., Ceiba 4:301. 1955. *Oerstedianthus carlsonae* (Steyerm.) Lundell, Phytologia 54:285. 1983. TYPE. MEXICO. CHIAPAS: Around Los Arcos, Los Lagos, 3 mi NW of Rancho San José and 34 mi SE of Comitán, 1,600 m, 15—20 Apr 1949 (fl), *M. Carlson 1744* (HOLOTYPE: F; ISOTYPE; EAP, not seen).

Ardisia erythrocarpus Lundell, Wrightia 2:59. 1960. *Oerstedianthus erythrocarpus* (Lundell) Lundell, Phytologia 48:141. 1981. TYPE. GUATEMALA. PETÉN: San Luis, km 52 of road S of village, without elev., 10 Jul 1959 (fr), *C. Lundell 16267* (HOLOTYPE: LL-TEX (F neg. no. 55604); ISOTYPES: LL-TEX, TEX, US).

Ardisia brevipes Lundell, Wrightia 3:97. 1964. *Oerstedianthus brevipes* (Lundell) Lundell, Phytologia 48:141. 1981. TYPE. MEXICO. VERACRUZ: Suchilapa, without elev., 10 Mar 1930 (fl), *C. Mell 576* (HOLOTYPE: US; ISOTYPE: F (F neg. no. 68136, LL neg. no. 1971-24), LL-TEX (F neg. no. 55610), NY).

Ardisia hirtella Lundell, Wrightia 3:98. 1964. *Oerstedianthus hirtella* (Lundell) Lundell, Phytologia 48:141. 1981. TYPE. BELIZE. EL CAYO: Retiro, without elev., 30 Jun–Aug 1936 (fl), *C. Lundell 6302* (HOLOTYPE: LL-TEX (F neg. no. 55615; ISOTYPES: F (F neg. no. 68223), GH-2 sheets, LL, MEXU, NY-2 sheets, TEX, US).

Ardisia trinitariae Lundell, Wrightia 5:62. 1974. *Oerstedianthus trinitariae* (Lundell) Lundell, Phytologia 48:142. 1981. TYPE. MEXICO. CHIAPAS: Municipio de La Trinitaria, slope at the Lago de Monte Bello, 25 mi E of La Trinitaria, 5,100 ft [1,554 m], 13 Apr 1965 (fl), *D. Breedlove 9721* (HOLOTYPE: LL-TEX, (F neg. no. 55631); ISOTYPES: CAS-DS, F (F neg. no. 68449).

Ardisia tuxtepecana Lundell, Wrightia 5:63. 1974. *Oerstedianthus tuxtepecanus* (Lundell) Lundell, Phytologia 48:142. 1981. TYPE. MEXICO. OAXACA: Rancho "Los Caracoles," ca. de Tuxtepec, without elev., Jul 1963 (fr), *J. Alcocer y C. Morales s.n.* (HOLOTYPE: LL, (F neg. no. 55632).

Shrubs to small trees 0.5–15 m tall, 2.5–25 cm in diam. **Branchlets** slender, terete, 1–3 mm in diam., very sparsely to densely puberulent of simple trichomes. **Leaves**: with leaf blades membranous, elliptic, 2.8–12.5 cm long, 0.9–5.8 cm wide, apically abruptly long acuminate, the acumen 0.5–2.2 cm long, basally obtuse, the midrib impressed above, prominently raised below, the secondary veins 14–30 pairs, prominulous above, prominently raised below, inconspicuously to conspicuously punctate and punctate-lineate, glabrous to scattered puberulent of simple trichomes on the upper and lower surface, especially along the midvein, the margins entire to crenate or serrate, flat; petiole slender, canaliculate, 0.5–1.1 cm long, glabrous. **Inflorescences** terminal, erect, pinnately paniculate, 1.5–12 cm long, 1.5–7 cm wide, shorter to slightly longer than the leaves, the rachis glabrous to densely puberulent of simple trichomes, the branches 4–9-flowered corymbs; peduncles nearly absent to 1 cm long, glabrous; inflorescence branch bracts caducous, membranous, oblong to obovate or oblanceolate, 3–9 mm long, 1–3 mm wide, apically acute, basally acute on sessile or short peti-

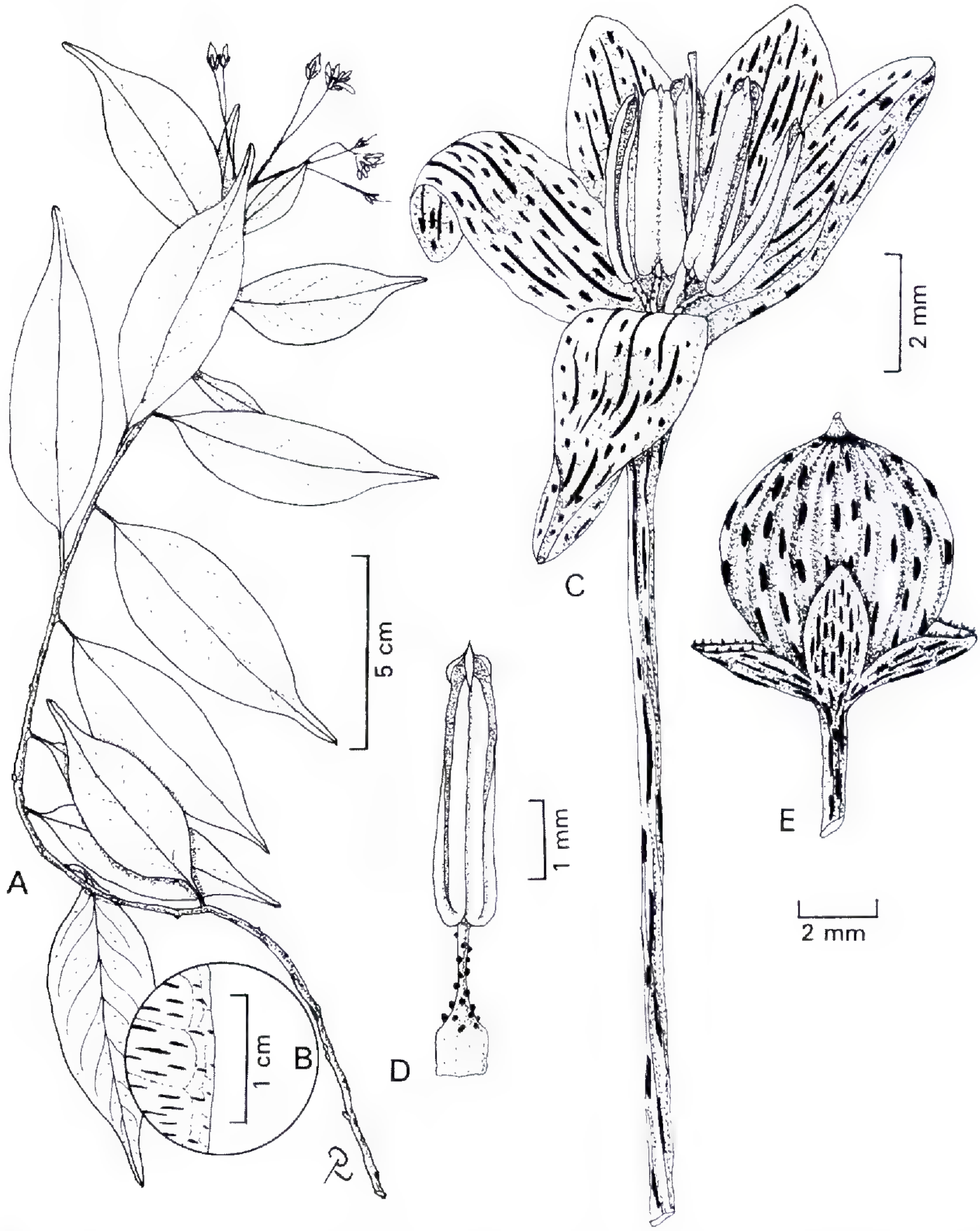


FIG. 4. *Ardisia tuerckheimii* Donn. Sm. **A.** Flowering branch. **B.** Detail of abaxial leaf surface. **C.** Flower. **D.** Stamen, showing adaxial surface. **E.** Fruit. A–D drawn from lectotype, *H. von Türckheim 1035* (US). E drawn from *E. Contreras 6668* (LL).

oles, the veins prominent, conspicuously and prominently punctate and punctate-lineate, glabrous, the margins entire; floral bracts apparently absent in the upper portion of the inflorescence with no apparent scars; pedicels slender, terete, 1.1–1.8 cm long, conspicuously and prominently punctate and punctate-lineate, glabrous to densely puberulent with simple trichomes. **Flowers** 5-

merous, white to pinkish; calyx lobes membranous, ovate to narrow oblong or oblanceolate, 1.5–3 mm long, 0.6–2 mm wide, apically acute to rounded, conspicuously and prominently punctate and punctate-lineate, glabrous to scattered papillae inside and out, the margins entire, scattered hirsute-ciliolate; corolla membranous, 4–10.2 mm long, the tube 0.7–1.9 mm long, the lobes oblong, 4.5–9.1 mm long, 1.6–5 mm wide, apically acute to rounded, conspicuously and prominently punctate and punctate-lineate, glabrous except rarely with a few yellow papillae at the base within, the margins entire, erose; stamens 4.7–6.2 mm long, the filaments 1.8–2.9 mm long, the staminal tube 0.2–0.9 mm long, the apically free portion 1.7–2.5 mm long, epunctate, with scattered yellow papillae near the base, the anthers free, lanceolate, 3.2–5.1 mm long, 0.6–1.6 mm wide, apically apiculate, basally subcordate, the connective inconspicuously punctate; pistil 5.2–8.3 mm long, glabrous, inconspicuously punctate, the ovary ovate, 0.8–1.5 mm long, the style 4.2–6.7 mm long, inconspicuously punctate and punctate-lineate, the ovules 8–15. **Fruit** globose, 5–6.4 mm long, inconspicuously punctate and punctate-lineate.

Distribution.—*Ardisia tuerckheimii* is known from southern Mexico (Oaxaca, Veracruz and Chiapas), southern Belize (Cayo and Toledo), northern Guatemala (Petén, Huehuetenango, Baja Verapaz, Alta Verapaz and Izabal) and northeastern Honduras (Cortés, Atlántida and Yoro). It grows from 800–1,500 m.

Ecology and conservation status.—*Ardisia tuerckheimii* occurs in primary and secondary, pine-oak-Liquidambar, lower montane and montane forests. This species appears to be quite common and not in any immediate danger.

Etymology.—This taxon was named in honor of the German-born collector Hans von Türckheim (1853–1920), who collected extensively in Guatemala and Santo Domingo.

In John Donnell Smith's (1888) original description he clearly based this taxon on the *H. von Türckheim 1035* collection, and it is agreed that his types are housed at the Smithsonian Institution (US). However, three specimens are housed at US with no indication as to which sheet is the holotype, thus necessitating the need to select a lectotype. One of these sheets US no. 1339941 was photographed by the Field Museum (F neg. no. 55673) and was de-accessioned and sent as a gift to C.L. Lundell (LL-TEX). The remaining two US sheets are of approximately equal value, one labeled as US no. 40099 and the other US as no. 1339942; the latter appears to have an original hand written label. Although C.L. Lundell labeled the US no. 40099 sheet as the "Type," he did not formally lectotypify the collection. Because the US no. 40099 sheet is of slightly better quality and has a lower accession number, making it more likely that John Donnell Smith used this material, at least in part, for his original description, we designate this sheet as the lectotype.

Ardisia tuerckheimii is an extremely variable species, which has led to its over description. Many of the collections from Mexico are glabrous or nearly so,

and gradually become more puberulent, as one moves south towards Honduras. However, because of this gradual gradation from glabrous to densely puberulent no clear justification can be found to recognize any of these proposed species and all are synonymized here. In fact the types of *Ardisia mitchellae* and *A. hirtella* were originally compared to *A. nigrescens* (including subsp. *donnellsmithii*), and not even compared to *A. tuerckheimii*, and separated based mostly on the differences in the indument, which is clearly different. *A. erythrocarpa* is unique only for its slightly larger fruits and slightly ciliated larger sepals. Populations of *A. brevipes* are unique only for their apparent subsessile fasciculate inflorescences with shorter peduncles, and with what are described as "bulbous" anther bases, and involuted petals apically. Populations of *A. carlsonae* are unique only for their slightly larger flowers, slightly smaller leaves and slightly obtuse anther. The type of *A. trinitariae* has slightly longer pedicels, slightly larger flowers, "bulbous" anthers bases and slightly oblong leaves. Finally, *A. tuxtepecana* differs slightly by its slender habit and smaller more densely puberulent leaves with slightly longer pedicels. Close examination of the total variation in this species shows that the slight differences, displayed by the synonymied taxa are not discontinous but fall within the range of variation of *A. tuerckheimii*.

Specimens examined. **MEXICO. Chiapas:** Mpio. La Trinitaria, slope at the Lago of Monte Bello, 25 mi E of La Trinitaria, 5,100 ft [1,554 m], 13 Apr 1965 (fr), *D. Breedlove 9733* (F, LL); 5,200 ft [1,585 m], 17 Aug 1966 (fl, fr), *D. Breedlove 14978* (F, LL, US); Mpio. La Trinitaria, forest along the Comitán River at its sumidero, Lagos de Montebello, 42 km NE of La Trinitaria, 1,300 m, 23 Oct 1971 (fl), *D. Breedlove & R. Thorne 21166* (F, LL, MO, NY); Mpio. La Trinitaria, slopes E of Laguna Tzikaw, Monte Bello National Park, 1,300 m, 16 Nov 1972 (fl), *D. Breedlove & R. Dressler 29601* (MO, TEX); Mpio. Las Margaritas, on the W side of Laguna Miramar E of San Quintín, 350 m, 11 Feb 1973 (fr), *D. Breedlove 33302* (MO); Mpio. Ocozocoautla de Espinosa, 32 km N of Ocozocoautla on road to Mal Paso, 800 m, 6 Oct 1974 (fr), *D. Breedlove 38200* (DS, LL, MO); Mpio. La Trinitaria, 4 km E of Laguna Tsiskaw near Dos Lagos, 1,300 m, 19 Oct 1974 (fl), *D. Breedlove 38764* (CAS, MO); Mpio. La Trinitaria, E of Laguna Tziscoa, Monte Bello National Park, 1,380 m, 18 Dec 1980 (fr), *D. Breedlove 48740* (LL, MO); Mpio. La Trinitaria, Near Cinco Lagos, Lagos de Montebello National Park, 1,372 m, 5 Oct 1981 (fl), *D. Breedlove 53339* (DUKE, F, GH, LL, MO, NY); 13 Oct 1981 (fr), *D. Breedlove 53425* (LL); Mpio. La Trinitaria, Cinco Lagunas, Lagos de Montebello National Park, 1,600 m, 24 May 1988 (fr), *D. Breedlove 68667* (CAS); A Jatu del Tigre, 30 km NW Ocozocuantla, without elev., 26 May 1950 (fr), *F. Miranda 6289* (MEXU); Mpio. Ocosingo, a los lados de la carretera, without elev., 7 Dec 1980 (fl), *T. Ramamoorthy et al. 1356* (MEXU, MO); Mpio. La Trinitaria, slope on the E side of Lago Tsikaw in the region of the Lagos de Montebello, 4,800 ft [1,463 m], 5 Jul 1967 (fr), *A. Shilom T. 2599* (F, LL); Mpio. La Trinitaria, near Parque Nacional Lagunas de Monte Bello, 40 km E of La Trinitaria, 1,470 m, 26 Oct 1989 (fl), *J. Soto et al. 13479* (BM). **Oaxaca:** Mpio. Santa María Chimalapa, Dto. Juchitán, Los Angeles, before Arroyo Seco, to Santa María Chimalapa, 33 km E of Mezquite, 16° 52' N, 94° 44' W, 250 m, 24 Mar 1988 (fr), *A. Campos et al. 1702* (MEXU, MO); *1715* (MEXU, MO); 2 km before Cuauhtemoc along Uxpanapa Road, 12° 06' N, 094° 54' W, 120 m, 4 Nov 1978 (fr), *G. Castillo C. 408* (LL, MEXU); Mpio. Juchitán, 24 km SE of Lázaro Cardenas,Santa María Chimalapa Road, 330 m, 11 Mar 1982 (fl), *R. Cedillo T. & R. Torres 1144* (LL, MEXU); Mpio. Santa María Chimalapa, near Santa María, 16° 55' N, 094° 40' 30" W, 300 m, 15 Sep 1984 (fr), *H. Hernández G. 433* (LL, MO); Mpio. Santa María Chimalapa, Río Milagro, ca. 3 km W of Santa María, 16° 55' N, 094° 42' W, 190 m, 13 Feb 1985 (fr), *H. Hernández G. 842* (LL, MO); Mpio. Santa María

Chimalapa, Arroyo Palomares, ca. 2.5 km N of Santa María, 16° 55' N, 094° 41' W, 250 m, 19 Feb 1985 (fl), *H. Hernández G. 896* (LL, MO); Mpio. Santa María Chimalapa, ca. 1.5 km NE of Santa María through Paso Tzajinmjeun del Río del Cortes, at junction of Paso Lagarto, 16° 55' N, 094° 40' 30" W, 250 m, 27 Feb 1985 (fl), *H. Hernández G. 935* (LL, MO); Mpio. Santa María Chimalapa, Arroyo Sangre, ca. 2 km al E de Santa María, 16° 54' 30" N, 094° 40' W, 250 m, 12 Mar 1985 (fl), *H. Hernández G. 985* (LL); Mpio. Santa María Chimalapa, ca. 10 km W of Santa María via Chicosaja, 16° 53' N, 094° 46' W, 250 m, 30 Mar 1985 (fl), *H. Hernández G. 1056* (LL, MO); Mpio. Santa María Chimalapa, Cañada del Río Negro, at Arroyo Huapond's mouth, ca. 15 km S de Santa María, 16° 56' N, 094° 39' 30" W, 300 m, 14 Oct 1985 (fr), *H. Hernández G. & C. González L. 1637* (FTG); Mpio. Santa María Chimalapa, Cerro Azul-Escolapa, ca. 8 km SW of Santa María, S of road to Lázaro Cardenas, 16° 51' 30" N, 094° 43' W, 400 m, 19 Oct 1985 (fr), *H. Hernández G. & C. González L. 1681* (FTG); Mpio. Santa María Chimalapa, mountain range at Paso Jugcuypac del Río Verde, ca. 8 km N of Santa María, 16° 57' 30" N, 094° 41' W, 500 m, 29 Oct 1985 (fr), *H. Hernández G. & C. González L. 1769* (FTG); Mpio. Santa María Chimalapa, Arroyo Sangre, ca. 0.2–0.5 km from mouth of Río Milagro, ca. 3 km SE of Santa María, 16° 54' N, 094° 40' 30" W, 200 m, 28 Dec 1985 (fr), *H. Hernández G. 1994* (FTG, LL); Mpio. Valle Nacional, 2 km W of Arroyo Seco, 17° 54' N, 096° 18' W, 200–300 m, 12 Oct 1992 (fl), *J. Meave del Castillo et al. 1480* (MEXU, MO); Mpio Santa María Jacatepec, Dtto. Tuxtepec, Predio El Aguila, W of San Agustin, entering by La Reforma, 28 km SW de Tuxtepec, road to Matias Romero, 17° 50' N, 096° 06 W, 550 m, 19 Jan 1988 (fr), *R. Torres C. 11039* (MEXU, MO); Mpio. Santa María Chimalapa, Dtto. Juchitán, Los Angeles before Arroyo Seco, 23.3 km E of Lázaro Cárdenas, toward Santa María Chimalapa, entering from El Mezquite, 16° 50' N, 094° 45' W, 400 m, 21 Jan 1988 (fr), *R. Torres C. & E. Martínez S. 11163* (MEXU, MO); Mpio. Santa María Jacatepec, Dtto. Tuxtepec, Predio del Aguila, at San Agustin, 25 km W of la Reforma, Ayozintepec highway, 17° 50' N, 096° 06' W, without elev., 21 Feb 1988 (fr), *R. Torres C. & L. Cortes A. 11500* (MEXU, MO); Mpio. San Juan Guichicobi, 7 km E of Sarabia, without elev., 6 Dec 1974 (fr), *M. Vázquez T. 1395* (FTG, MEXU, MO); Mpio. Matías Romero, ca. 22 km S of Esmeralda, ca 9 km S of La Floresta sawmill, hills S of Río Verde, 17° 01' N, 094° 49' W, 290 m, 26 Mar 1981 (fl), *T. Wendt et al. 3081* (LL-2 sheets, MO); Mpio. Matías Romero, 7.2 km W of Esmeralda, along La Laguna-Sarabia, then 2.6 km S, 17° 07' N, 094° 49' W, 200 m, 8 Mar 1982 (fl), *T. Wendt et al. 3623* (LL). **Veracruz:** Mpio. Catemaco, Lado NE of Lago Catemaco E of Coyame, ca. 450 m, 27 Oct 1971 (fr), *J. Beaman 5186* (F, LL); Mpio. San Andrés Tuxtla, Estación Biológica de Los Tuxtlas, ca. 20 km N of Catemáco, "Eblotrolotu," without elev., ca. 1970 (fl), *J. Calzada 227* (F, LL, MEXU); 6 Apr 1972 (fl), *J. Calzada 723* (F, MEXU); Mpio. San Andrés Tuxtla, Estación Biológica de Los Tuxtlas, without elev., 26 Oct 1972 (fr), *R. Cedillo T. & J. Calzada 48* (F, LL, MEXU); 500 m, 8 Apr 1972 (fl), *R. Cedillo T. 164* (F, LL, NY-2 sheets); Mpio. Catemáco, Estación Biológica Tropical Los Tuxtlas, 150 m, 16 May 1981 (fl), *R. Cedillo T. & D. Lorence 702* (F, LL); Mpio. San Andrés Tuxtla, Estación Biológica de Los Tuxtlas, UNAM road to La Laguna Escondida, 18° 35' N, 095° 04 W, without elev., 29 Mar 1979 (fl), *M. Dillon et al. 1831* (F, MO, NY, TEX); Mpio. Hidalgotitlan, kms 0–2 del camino Plan de Arroyos-Alvaro Obregon, 17° 15' N, 094° 40 W, 130–150 m, 14 Apr 1974 (fr), *B. Dorantes 2802* (MEXU, MO); Mpio. Hidalgotitlan, Cedillo-La Escuadra road, 150 m, 30 Sep 1974 (fr), *B. Dorantes 3576* (MEXU, MO); Mpio. Hidalgotitlan, road from Hermanos Cedillo to la Laguna, 17° 15 N, 094° 40' W, 140 m, 9 Oct 1974 (fr), *B. Dorantes 3617* (MEXU, MO); Mpio. Jesus Carranza, km 10 Cedillo-Francisco Villa road, 17° 20' N, 094° 40' W, 150 m, 18 Jan 1975 (fr), *B. Dorantes 3941* (F, LL, MEXU, MO); Hills between Playa Escondida and Estación Biológica Los Tuxtlas, 50–100 m, 27 May 1981 (fr), *A. Gentry et al. 32337* (MO); Coatzacoalcos-Las Choapas, 2 km from the exit, 50 m, 18 Nov 1968 (fr), *A. Gómez P. 3909* (MEXU); Mpio. San Andrés Tuxtla, Lote 67, Estación Biológica Tropical Los Tuxtlas, 350 m, 28 Mar 1983 (fl), *G. Ibarra M. & L. Córtes A. 523* (MEXU, MO); 18° 34–36' N, 095° 04–09' W, 160 m, 3 Nov 1983 (fr), *G. Ibarra M. & C. Lundell 990* (MEXU, MO); 200 m, 18 Apr 1987 (fl), *G. Ibarra M. & N. Pérez N. 3092* (FTG, MEXU, MO); 300 m, 13 Apr 1991 (fl), *G. Ibarra M. & S. Sinaca C. 3554* (MEXU, NY); Mpio. Mecayapan–Soteapan border, ridgetop of spur on N side of Volcán San Martín Pajapan, ca. 100 m below the summit ridge, 6 km NE of Pajapan, 18° 18' 30" N, 094° 43' 30 W, 1,100 m, 15 Jul 1982 (ster.), *M. Nee et al. 25027* (F); Mpio. Catemáco, along road from Catemáco to Coyame, 2.5 km E of junction with road to Sontecomapan

and 0.5 km from N edge of Laguna de Catemáco, 6 km NE of Catemáco, 18° 27' N, 095° 03' 30" W, 350 m, 20 Apr 1983 (fl), *M. Nee et al. 26675* (F, LL, MO, NY); Mpio. San Andrés Tuxtla, Estación Biológica de Los Tuxtlas, "Ebitrolotu, without elev., 10 Mar 1976 (fr), *D. Piñero 15B* (MEXU, MO); Mpio. San Andrés Tuxtla, Estación Biológica de Los Tuxtlas, without elev., 28 Oct 1981 (fr), *T. Ramamoorthy 2617* (MEXU, MO); 25 Mar 1982 (fl), *T. Ramamoorthy 3457* (MEXU, MO); 17 Sep 1982 (fr), *T. Ramamoorthy 4148* (MEXU, MO); 22 Apr 1970 (fl), *M. Rosas 1879* (MEXU); Mpio. San Andrés Tuxtla, Estación Biológica de Los Tuxtlas, Laguna Zacatal 2.5 km NW, 18° 34–36' N, 095° 04–09' W, 200 m, 9 Apr 1985 (fl), *S. Sinaca C. & E. Aparicio 31* (MEXU, MO); Mpio. Hidalgotitlán, brecha Hnos. Cedillo-La Escuadra, 200 m, 7 Mar 1974 (fl), *M. Vázquez T. et al. 125* (BM, MEXU), Mpio. Hidalgotitlán, Río Soloxuchil between Hermanos Cedillo and La Escuadra, 17° 17' N, 094° 38' W, 150 m, 3 Apr 1974 (fl), *M. Vázquez T. et al. 333* (F); Mpio. Hidalgotitlán, Hermanos Cedillo-La Escuadra por El Camino a Pancho Villa, 17° 16' N, 094° 37' W, 152 m, 20 Oct 1974 (fr), *M. Vázquez T. et al. 1241* (F); Mpio. Jesús Carranza, 2 km N of Poblado, 17° 16' N, 094° 40' W, 120 m, 1 Nov 1983 (fr), *M. Vázquez T. et al. 2654* (LL); 17 Apr 1983 (fl), *A. Villalobos C. et al. 28* (LL, MO); Mpio. San Andrés Tuxtla, Estación Biológica de Los Tuxtlas, ca. 20 km N of Catemáco, 140 m, 6 Apr 1973 (fl), *A. Villegas H. 84* (F, LL); Mpio. hills S of Minatitlán, ca. 27 km E of La Laguna, 17° 14' N, 094° 18' W, 250 m, 21 Feb 1981 (fr), *T. Wendt et al. 2911* (LL); Mpio. Hidalgotitlán, Laguna-Sarabia, 1 km W of Río Chachijalpa, 30 km al W de La Laguna, 17° 12' N, 094° 46' W, 100 m, 26 Feb 1981 (fl), *T. Wendt et al. 2935* (LL); Mpio. Hidalgotitlán, Cenotes 0.3 km W of La Raya, 6.5 km N of La Laguna, along road to Poblado 7, 17° 19' N, 094° 30' W, 130 m, 30 Mar 1981 (fl), *T. Wendt et al. 3106* (LL); Mpio. Minatitlán, hills S of Poblado 11, ca. 27 km E of La Laguna, 17° 14' N, 094° 17' W, 300 m, 3 Jun 1981 (fr), *T. Wendt et al. 3407* (LL); Mpio. Minatitlán, 2 km N of Uxpanapa, Poblado 12, along road to Poblado 13, 17° 14' N, 094° 13' W, 130 m, 17 May 1983 (fr), *T. Wendt et al. 4107* (LL); Mpio. Minatitlán, hills S of Poblado 11, ca. 27 km E of La Laguna, 17° 14' N, 094° 30' W, 250 m, 26 Apr 1985 (fr), *T. Wendt et al. 4841* (LL, NY). **BELIZE. Cayo:** Mountain Pine Ridge, without elev., 24 Feb 1931 (fr), *H. Bartlett 11742* (F); El Cayo, without elev., 13 Apr 1931 (fr), *H. Bartlett 12926* (F, NY); San Antonio, without elev., 6 May 1931 (fr), *H. Bartlett 13076* (F); Vicinity of La Flor at Río de la Flor, 6 mi S of Grand de Oro, 1,700–2,000 ft [518–610 m], 3 Jun 1973 (fr), *T. Croat 23750* (MO); Along road between Millionario and Grand de Oro, 1,700 ft [518 m], 2–3 Jun 1973 (fr), *T. Croat 23689* (LL, MO); El Cayo road, without elev., 16 Feb 1938 (fr), *P. Gentle 2181* (LL, NY); Vaca, without elev., 11 Apr 1938 (fr), *P. Gentle 2476* (A, F, NY); Humming Bird Highway, without elev., 24 Mar 1955 (fr), *P. Gentle 8637* (LL-2 sheets, TEX); Río Frio Caves road, Augustine, Mountain Pine Ridge Forest Reserve, 460 m, 26 May 1989 (fr), *J. Meave & A. Howe 1404* (MO); María Camp, 800 m, 24 Mar 1954 (fr), *A. Molina R. 103* (F); At Río Frio Cave near Augustine, ca. 300 m, 5 Jul 1970 (fr), *D. Spellman 1583* (MO); Vicinity of Puenta natural, Chiquibul Forest Reserve, 1,700–1,800 ft [518–549 m], 26 Apr 1969 (fr), *G. Proctor 30122* (LL); Millionario, 2,000 ft [610 m], 12 Dec 1968 (fl), *G. Proctor 29864* (LL); San Pastor track, 450 m, 15 Apr 1995 (fr), *C. Whitefoord 9014* (BR); Chiquibul Forest Reserve, Engineers' Camp, 500 m, 27 Apr 1998 (fr), *C. Whitefoord 10378* (MO). **Toledo:** Ca. 40 km SW of Punta Gorda Dolores Estate, 15° 59' N, 089° 13' W, without elev., 30 Jan 1990 (fr), *M. Balick et al. 2500* (TEX); First and second bridges near Columbia Forest Station, without elev., 26 Jun 1972 (fr), *J. Dwyer 9954* (LL, MO); Edwards Road beyond Columbia, without elev., 8 Jun 1947 (fr), *P. Gentle 6226* (GH, LL-2 sheets, PH, TEX); Near San Antonio, without elev., 22 Nov 1951 (fl), *P. Gentle 7525* (GH, LL-2 sheets, PH, TEX); SW-ern Maya Mountains, Columbia River Forest Reserve, Union Camp, 16° 23' N, 098° 09' W, 700–750 m, 5 Apr 1992 (fr), *B. Holst 4015* (MO); Columbia River Forest Reserve, Union Camp, ca. 3 km W of SW end of Little Quartz Ridge, 16° 23' 53" N, 089° 07.34" W, 700–750 m, 22 Feb 1997 (fr), *B. Holst 5975* (BRH, F, FTG, MO, SEL); Temash River, Pueblo Birejo, 1,700 ft [518 m], 19 Feb 1934 (fl, fr), *W. Schipp S-692* (A, BM, F, GH, K, MO, NY-2 sheets); Union Camp, 750 m, 15 May 1979 (fr), *C. Whitefoord 1739* (MO); Blue Creek, without elev., 12 Jun 1981 (fr), *C. Whitefoord 3208* (MO); 2 Oct 1992 (fl), *C. Whitefoord 8275* (BM). **GUATEMALA. Alta Verapaz:** Tucuru, Finca de Remedios, without elev., 20 Aug 1979 (fl), *J. Bocke & S. Utzschneider 2948* (NY); On Cobán Road, km 285–286, between Chiracte and Chapultepec farm, without elev., 24 May 1964 (fr), *E. Contreras 4773* (LL-2 sheets); *4775* (LL-2 sheets); Chapultepec farm, ca. 1 km N, without elev., 26 May 1964 (fr), *E. Contreras*

4809 (GH, LL-2 sheets, TEX); Chahal, bordering Río Chiyú, 3.5 km NWW, 28 Sep 1968 (fl), *E. Contreras 7742* (DUKE, F, G, LL-3 sheets); Chahal, on Sepur Ranch, bordering Río Chahal, 2 km S, without elev., 8 Oct 1968 (fl), *E. Contreras 7860* (F, LL-3 sheets); Secoyoetí, near the Finca Sepacuite, without elev., 14 Apr 1902 (fr), *O. Cook & R. Griggs 611* (US); Tamahú, 2,500 ft [m], 17 Nov 1920 (fl), *H. Johnson 1007* (F, US); Between Cobán and Finca Chimoté, near Rubeltein, 800–1,500 m, 25 Feb 1942 (fl, fr), *J. Steyermark 44205* (F). **Baja Verapaz:** Niño Perdido, bordering Río San Jose, 8 km N, without elev., 26 May 1977 (fl-bud), *C. Lundell & E. Contreras 20986* (LL-2 sheets, PH); 28 May 1977 (fr), *C. Lundell & E. Contreras 21012* (LL-2 sheets, PH); Paujal, 1,000 m, Oct 1912 (fl), *H. von Türckheim 3922* (US). **Huehuetenango:** Cerro Jolomtac, above Finca San Rafael, Sierra de los Cuchumatanes, 900–1,200 m, 22 Jul 1942 (fr), *J. Steyermark 49143* (F); Between Cerro Chiblac and Finca San Rafael, between Ixcan and Finca San Rafael, Sierra de los Cuchumatanes, 200–800 m, 24 Jul 1942 (fr), *J. Steyermark 49475* (F); Cerro Victoria, across river from Finca San Rafael, Sierra de los Cuchumatanes, 800 m, 27 Jul 1942 (fl), *J. Steyermark 49644* (F). **Izabal:** El Estor, without elev., 5 Mar 1972 (fr), *E. Contreras 11145* (DUKE, LL-2 sheets); 17 Mar 1972 (fr), *E. Contreras 11357* (DUKE, LL-2 sheets); Jocolo, without elev., 25 Nov 1920 (fl), *H. Johnson 1024* (F); Cadenas, ca 6 km S of the village, on old brecha to Río Chocon Arriba, without elev., 20 Feb 1975 (fr), *C. Lundell & E. Contreras 19016* (LL-3 sheets); El Estor, bordering Río Sarco, without elev., 26 May 1975 (fr), *C. Lundell & E. Contreras 19358* (LL-2 sheets); Carosal bordeando Río Sorstún, without elev., 21 Jan 1969 (fr), *R. Tún O. 120* (F, LL); Entre caserios Ceja y Cienaga, 15° 40' N, 089° W, without elev., 9 Mar 1972 (fr), *R. Tún O. 2300* (F, LL). **Petén:** Remate, on Tikal Road ca. 6 km NE of village, without elev., 16 Mar 1960 (fr), *E. Contreras 678* (LL-2 sheets, TEX); Dolores, bordering Arroyo Ixcol, E of village, 800 m, 14 Apr 1961 (fr), *E. Contreras 2071* (LL-3 sheets, TEX); Dolores, between kms 83–84 of Machaquila Road, without elev., 24 Apr 1961 (fr), *E. Contreras 2171* (G, LL-2 sheets); Dolores, bordering pineland ca 2 km south of village, without elev., 3 May 1961 (fr), *E. Contreras 2243* (DUKE, LL-2 sheets, PH, TEX); Dolores, km 79 of Machaquila Road, without elev., 14 Jul 1961 (fl), *E. Contreras 2605* (DUKE, LL-2 sheets, TEX); Dolores, ca. 2 km S, without elev., 18 Jul 1961 (fl), *E. Contreras 2625* (LL-2 sheets); Santo Toribio, bordering the village, without elev., 28 Jul 1961 (fl), *E. Contreras 2703* (LL-2 sheets, TEX); Milpa Grande at Macanché, without elev., 5 Mar 1966 (fr), *E. Contreras 5511* (F, LL); Cadenas, W of km 166–167 of Poptun Road, without elev., 12 Aug 1966 (fl, fr), *E. Contreras 5956* (GH, LL-2 sheets, TEX); Chinchila, 3 km from San Luis on Sebol Road, without elev., 12 Oct 1966 (fl), *E. Contreras 6384* (G, LL-3 sheets); Poptun Road, km 82, without elev., 14 Nov 1966 (fr), *E. Contreras 6595* (LL-3 sheets); La Cumbre, at km 142 of road, without elev., 2 Mar 1967 (fr), *E. Contreras 6634* (LL-2 sheets); Seamay, without elev., 6 Mar 1967 (fr), *E. Contreras 6668* (F, G, LL-3 sheets); San Pedro on Cadenas Road, without elev., 13 Aug 1967 (fr), *E. Contreras 7018* (F, G-2 sheets, LL-3 sheets); San Pedro on Cadenas Road, bordering river, without elev., 9 Jan 1970 (fr), *E. Contreras 9481* (DUKE, LL-3 sheets); Ca 5 mi S of Tikal National Park, without elev., 19 Jun 1973 (fr), *J. Dwyer 11262* (LL, MO); San Luis, km 52 of road S of village, without elev., 12 Jul 1959 (fr), *C. Lundell 16382* (F, LL-3 sheets, TEX); Cadenas, bordering Rio Gracias a Dios, without elev., 7 Sep 1975 (fr), *C. Lundell & E. Contreras 19805* (LL-2 sheets, NY, PH); La Cumbre, on Pusila Road, N ca. 4.5 km, without elev., 30 Aug 1976 (fl), *C. Lundell & E. Contreras 20283* (GH, LL-2 sheets); La Cumbre, Sapurul, without elev., 18 Apr 1977 (fr), *C. Lundell & E. Contreras 20829* (LL-2 sheets); Santa Elena a Petén en orillando camino para Puerto Mendez, lado N km 164, without elev., 17 Mar 1970 (fr), *R. Tún O. 774a* (F, LL); 777 (F, LL, MO, NY); Santa Elena, behind the school at Colpeten, ca. 200 m, 5 Jun 1970 (fr), *R. Tún O. 1182* (F, LL); San Luís, along road to Poctún, km 119, without elev., 3 Dec 1970 (fl), *R. Tún O. 1451* (F, LL, MO, NY); 117, without elev., 6 Dec 1970 (fr), *R. Tún O. 1479* (F, LL); Along road to Arroyo Dolores, ca 300 m S of Dolores, without elev., 16 Feb 1971 (fr), *R. Tún O. 1587* (F, LL); Dolores, without elev., 14 Feb 1971 (fr), *R. Tún O. 1563* (F, LL); Santa Elena, along road to La Libertad, km 9, SE side, without elev., 8 May 1971 (fr), *R. Tún O. 1753* (F, LL, MO); Poptún, along road to San Luís, km 117, ca 125 m W of road, without elev., 7 Jan 1972 (fr), *R. Tún O. 2158* (F, LL, MO, NY). **HONDURAS**. **Atlántida:** Mpio. Esparta, 19.2 km E of Tela on the Tela-Ceiba Hwy., ca. 1.5 km S of the hwy., near San Francisco de Soco, 15° 44' N, 087° 21' W, 50–100 m, 15 Apr 1994

(fl), *A. Brant & R. Zúniga 2842* (F, MEXU, MO); Along road for municipal water supple of Tela, Lancetilla Botanical Gardens, on road ca. 2 mi WSW of Tela and S of main hwy., 15° 44' N, 087° 27' W, 70–90 m, 9 Feb 1987 (fr), *T. Croat & D. Hannon 64596* (FTG, MO); Tela, Lancetilla Valley, valley above Experiment Station, along stream and slopes above stream but below the dam, 15° 43' 00" N, 087° 27' 30" W, 30–60 m, 4 Nov 1988 (fr), *J. MacDougal et al. 3159* (MO); Vicinity of Tela, 500 ft [152 m], 6 May 1926 (fl), *E. Mitchell 98* (GH); Lancetilla, 7 km SW de Tela, 150 m, 3 Feb 1986 (fr), *E. Mondragón 128* (MO); Vicinity of San Alejo, at base of hills S of San Alejo near Río San Alejo, 150–270 m, 22–27 Apr 1947 (fl), *P. Standley 7616* (F); Lancetilla Valley, near Tela, 20–600 m, 6 Dec 1927–20 Mar 1928 (fr), *P. Standley 52643* (A, F, US); *52983* (A, F, US); *53120* (A, F, US); *55598* (F); *56563* (A, F, US); *56803* (A, F, US); *56882* (F, GH, US). **Cortés:** Along Río Lindo near Carrizal, 550 m, 12 Apr 1951 (fl), *L. Williams & A. Molina R. 17804* (F, GH, US). **Yoro:** Río Texiguat watershed, 15° 30' 10" N, 087° 26' 32" W, 220 m, 18 Apr 1995 (fl), *T. Hawkins & M. Merello 767* (F, MEXU, MO, NY, TEX); Near Progreso, without elev., 26 Mar 1929 (fl), *W. Hottle 26* (F). **Unknown locality in Honduras:** Puerto Sierra, forest along Highland Creek, without elev., 18 Jan 1903 (fr), *P. Wilson 69* (NY, US).

ACKNOWLEDGMENTS

We thank the Missouri Botanical Garden and the Flora Mesoamericana Project, as well as the Fairchild Tropical Garden, for their support, to bring Ricketson and Pipoly together to work on the project. We gratefully acknowledge the loans from many herbaria that made the study possible, along with our collaborators who supplied us with much of the critical material. Richard G. Walter (formally of CS) and Gerrit Davidse (MO) generously gave of their time to provide thorough reviews of the entire manuscript. Special thanks are due to Roy Gereau for his critical review of the Latin diagnoses published herein. The drawings were prepared by Jon Ricketson. Finally, the assistance of Jon Ricketson's volunteer, Mary Bard, greatly facilitated the annotation and movement of specimens.

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NUMERICAL LIST OF TAXA

1a. *Ardisia nigrescens* Oerst. subsp. *nigrescens*
1b. *Ardisia nigrescens* Oerst. subsp. *donnellsmithii* (Mez) Ricketson & Pipoly
2. *Ardisia verdisepala* Ricketson & Pipoly
3. *Ardisia tuerckheimii* Donn. Sm.

LIST OF EXSICCATAE

The figures in parentheses refer to the numbers from the numerical list of taxa. Collection numbers in **boldface** type indicate type specimens.

J. Alcocer, J. & C. Morales s.n. (**3**); Alcorn, J. 2937 (1a).

Balick, M. et al. 2500 (3); Bartlett, H. 11742 (3);12926 (3);13076 (3);Beaman, J.5186 (3);Boeke, J.& S.Utzschneider 2948 (3);Brant, A.& R.Zúniga 2842 (3); Breedlove, D. 9721 (**3**); 9733 (3); 14978 (3); 15702 (1a); 24232 (1a); 27927 (2); 33006 (2); 33302 (3); 38200 (3); 38709 (1b); 38764 (3); 47348 (1b); 48740 (3); 49112 (1a); 49160 (1b); 49445 (2); 49970 (1b); 52487 (2); 52591 (**2**); 53339 (3); 53425 (3); 57759 (1b); 68667 (3); Breedlove, D. & F. Almeda 57228 (1b); 57210 (2); 57370 (1a); 57927 (1b); Breedlove, D. & R. Dressler 29601 (3); Breedlove, D. & B. Keller 49485 (2); Breedlove, D. & A. Smith 22120 (2); 22121 (2); Breedlove, D. & R. Thorne 21166 (3).

Calzada, J. 227 (3); 723 (3); Campos, A. et al. 1702 (3); 1715 (3); Carlson, M. 1744 (**3**); Castillo C., G. 408 (3); Cedillo T., R. 164 (3); Cedillo T., R. & J. Calzada 48 (3); Cedillo T., R. & D. Lorence 702 (3); Cedillo T., R. & R. Torres 1144 (3); Chiang, F. 301 (1a); 377 (1a); Contreras, E. 678 (3); 2071 (3); 2171 (3); 2243 (3); 2605 (3); 2625 (3); 2703 (3); 4254 (1b); 4291 (1b); 4667 (1b); 4773 (3); 4775 (3); 4809 (3); 5414 (1b); 5511 (3); 5956 (3); 6290 (1b); 6384 (3); 6595 (3); 6634 (3); 6668 (3); 7018 (3); 7742 (3); 7860 (3); 9481 (3); 11145 (3); 11357 (3); Contreras, E. & C. Lundell 20069 (1b); Cook, O. & R. Griggs 611 (3); 767 (1b); Cowan, C. et al. 3935 (1a); Croat, T. 23689 (3); 23750 (3); Croat, T. & D. Hannon 64596 (3).

Davidse, G. 36051 (1b); Davidse, G. & A. Brant 32362 (1b); Dillon, M. et al. 1831 (3); Dorantes, B. 2802 (3); 3576 (3); 3617 (3); 3941 (3); Dressler, R. 1507 (1a); 1637 (1b); Dwyer, J. 9954 (3); 11262 (3).

Gentle, P. 2181 (3); 2476 (3); 2798 (1b); 4522 (1b); 4895 (1b); 5231 (1b); 6177 (1b); 6226 (3); 6729 (1b); 6980 (1b); 7525 (3); 7639 (1b); 8637 (3); Gentry, A. et al. 32337 (3); Goll, G. 261 (1b); Gómez P., A. 3909 (3); 7885 (1a).

Hahn, M. 21 (1a); Hawkins, T. 1443A (1b); Hawkins, T. & M. Merello 767 (3); Hernández X., E. 102 (1a); Hernández G., H. 433 (3); 842 (3); 896 (3); 935 (3); 985 (3); 1056 (3); 1994 (3); Hernández G., H. & C. González L. 1637 (3); 1681 (3); 1769 (3); Hernández G., H. & R. Torres 813 (1a); Holst, B. 4015 (3); 5975 (3); Hottle, W. 26 (3).
Ibarra M., G. & L. Córtes A. 523 (3); Ibarra M., G. & C. Lundell 990 (3); Ibarra M., G. & N. Pérez N. 3092 (3); Ibarra M., G. & S. Sinaca C. 3554 (3).

Johnson, H. 228 (1b); 1007 (3); 1024 (3).

Karwinsky, W. 450 (1a).

Liebmann, F. 28A (1a); 28B (**1a**); 15341 (1a); Little, E. 25392 (1a); Lundell, C. 6302 (**3**); 16267 (**3**); 16382 (3); 17823 (1b); 17923 (1b); 17978 (1b); 18039 (1b); 18040 (1b); 18133 (1b); C. Lundell & E. Contreras 19016 (3); 19358 (3); 19805 (3); 20283 (3); 20829 (3); 20986 (3); 21012 (3); Lundell, C. & A. Lundell 7130 (1a).

MacDougal, J. et al. 3159 (3); Martínez S., E. 6523 (1b); 6537 (1b); 6901 (1b); 7411 (1b); 7622 (1b); 7658 (1b); 8059 (1b); 8427 (1b); 9318 (1b); 9361 (1b); 9581 (1b); 10106 (1b); 10132 (1b); 11075 (1b); 11531 (1b); 13454 (1b); 13616 (1b); 15982 (1b); 21333 (1b); Martínez S., E. & G. Aguilar 8630 (1b); 8790 (1b); 13707 (1b); Martínez-Calderón, G. 209 (1a); 828 (1a); Meave, J. & A. Howe 1404 (3); Meave del Castillo, J. et al. 1480 (3); Medina A., M. & F. Vazquez B. 379 (1a); Mell, C. 576 (**3**); Méndez G., A. 4445 (2); Méndez T., A. 5097 (2); 5469 (2); 5640 (2); 5667 (2); 5837 (2); 5842 (2); 6052 (2); 6112 (2); 6211 (2); Mendez T., A. & M. Concepcion Mtz. de Lopez 9499 (1a); Miranda, F. 6289 (3); Mitchell, E. 66 (**3**); 98 (3); Molina R., A. 103 (3); Mondragón, E. 128 (3).

Nee, M. et al. 25027 (3); 26675 (3).

Peck, M. 576 (1b); Piñero, D. 15B (3); Proctor, G. 29864 (3); 30122 (3).

Ramamoorthy, T. 2617 (3); 3457 (3); 4148 (3); Ramamoorthy, T. et al. 1356 (3); Ramírez C., D. s.n. (1a); Reznicek, A. et al. 187 (1a); Rosas, M. 1879 (3).

Sandino, J. 181 (1a); Sessé, M. et al. 679 (1a); 730 (1a); Schatz, G. et al. 1195 (1a); Schipp, W. 287 (1b); 478 (1b); 482 (1b); S-692 (3); Schnée, L. & P. Maury s.n. (1a); Shilom T., A. 2599 (3); Sinaca C., S. & E. Aparicio 31 (3); Soto, J. et al. 13479 (3); Spellman, D. 1583 (3); Standley, P. 7616 (3); 52643 (3); 52983 (3); 53120 (3); 55598 (3); 56563 (3); 56803 (3); 56882 (3); Stevens, W. & E. Martínez S. 25849 (1b); Stevenson V., N. (1b); Steyermark, J. 44284 (1b); 44383 (1b); 45161 (1b); 49253 (1b); 45427 (1b); 45493 (1b); 44205 (3); 49143 (3); 49475 (3); 49644 (3).

Thompson, B. & B. Fields 379 (1a); Torres C., R. 11039 (3); Torres C., R. & L. Cortes A. 11500 (3); Torres C., R. & E. Martínez S. 11163 (3); Tún O., R. 120 (3); 774a (3); 777 (3); 1182 (3); 1451 (3); 1479 (3); 1587 (3); 1563 (3); 1753 (3); 2158 (3); 2300 (3); Türckheim, H. von 1035 (**3**); 3922 (3); 7766 (**1b**); 7918 (1b); 8707 [II978] (1b); II163 (1b).

Valdivia Q., P. 2407 (1b); Vázquez T., M. 1395 (3); Vázquez T., M. et al. 125 (3); 333 (3); 1241 (3); 2654 (3); Ventura A., F. 13621 (1a); 20767 (1a); Villalobos C., A. et al. 28 (3); Villegas H., A. 84 (3).

Wendt, T. et al. 2911 (3); 2935 (3); 3081 (3); 3106 (3); 3407 (3); 3623 (3); 4107 (3); 4841 (3); Whitefoord, C. 1739 (3); 3208 (3); 8275 (3); 9014 (3); 10378 (3); Williams, L. & A. Molina R. 17804 (3); Wilson, P. 69 (3).

BOOK NOTICES

Systematics/Monographs/Floras/Guides

R.P. (Rod) Randall. 2002. **A Global Compendium of Weeds.** (ISBN 0-9587439-8-3, hbk.). R.G. and F.J. Richardson, P.O. Box 42, Meredith, Victoria 3333, Australia. (Orders: www.weedinfo.com.au, richardson@weedinfo.com.au, +61-3-5286-1533 fax, VISA, MasterCard, BankCard, AE, checks [Australian dollars only] payable to R.G. and F.J. Richardson). $A165.00 plus $A10 postage within Australia, overseas postage: please ask for a quote, 944 pp., almost 21,000 entries, 6 3/4 × 9 3/4".

From the backcover.—"Predicting which plants will become weeds is difficult, with the single most important indicator of a species' weed potential being a documented weedy history."

"Until now, the most comprehensive coverage of the world's weed flora was produced in 1979 and listed 6400 species. In this compendium, Rod Randall has compiled a list of almost 21,000 entries, as well as a comprehensive index containing more than 15,000 alternate scientific names and 27,000 common names in numerous languages."

"A *Global Compendium of Weeds* is specifically designed to give anyone interested in the weed potential of a plant a report on its status with, most importantly, further avenues of finding more information through extensive reference listing."

Having received a recent request for information on dragon grass or Chinese alpine rush (*Poa sphondylodes*), I checked the list and to my surprise found it listed. The entry came with eight references that presumably lead you to additional information. A couple of the references also include websites that I checked...two worked and one had already changed addresses. Not a surprise. The index is extensive and includes common and alternate names (synonyms). Table 1 is the source codes (references with the taxonomic and geographic entries) with references and includes 300 references. Table 2 is the source codes for each region represented in the book. This an impressive compilation.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

Carmine Stahl and Rita McElvaney. 2003. **Trees of Texas: An Easy Guide to Leaf Identification.** (ISBN 1-58544-242-9, hbk.). Texas A&M University Press, John H. Lindsey Bldg., Lewis St. 4354 TAMU, College Station, TX 77843-4354, U.S.A. (Orders: wlawrence@tamu.edu, http://www.tamu.edu/upress, 800-826-8911). $29.95 hbk., 338 pp., 18 color, 270 b/w photos, 1 map, Bib., Index, 7 appendices, 8 1/2" × 11".

This book contains numerous life-sized leaf, flower, and fruit images. With more than 200 native and naturalized species organized by leaf shape, it leaves out a number of species. The genus *Crataegus* (hawthorn) has 25–30 species in Texas and Stahl and McElvaney cover nine species. Three species of *Prunus* are cover and yet there are a dozen or more in the state. Nothing is wrong here but one needs to keep in mind that *Trees of Texas: An Easy Guide to Leaf Identification* is a guide to the more common trees of Texas; a very nice one at that with photographs that are sharp and crisp with detail. —*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

A REVISION OF THE *PSIDIUM SALUTARE* COMPLEX (MYRTACEAE)

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ABSTRACT

The *Psidium salutare* complex is revised with keys, descriptions, maps, and illustrations and is considered to consist of *P. laruotteanum* (with no additional subspecific taxa) and *P. salutare* (with a total of five varieties). This complex ranges from eastern temperate South America to Mexico and Central America. The following taxa are lectotypified: *Calycolpus parviflorus* Sagot, *Myrtus acutata* O. Berg, *Myrtus blanchetiana* O. Berg, *Myrtus cuspidata* O. Berg, *Myrtus cuspidata* var. *tetramera* O. Berg, *Myrtus incana* O. Berg, *Myrtus mucronata* Cambess., *Myrtus nivea* O. Berg, *Myrtus pubescens* O. Berg, *Myrtus rigida* O. Berg, *Myrtus sellowiana* O. Berg, *Myrtus sericea* var. *fruticosa* O. Berg, *Myrtus suffruticosa* O. Berg, *Myrtus suffruticosa* var. *latifolia* O. Berg, *Psidium guayabita* A. Rich., *Psidium pohlianum* O. Berg, *Psidium salutare* var. *laxum* O. Berg and *Psidium salutare* var. *subalternum* O. Berg. The following new combinations are made: *Psidium salutare* var. *decussatum* (DC.) Landrum, *Psidium salutare* var. *mucronatum* (Cambess.) Landrum, *Psidium salutare* var. *pohlianum* (O. Berg) Landrum, and *Psidium salutare* var. *sericeum* (Cambess.) Landrum.

RESUMEN

Se hace una revisión del complejo de *Psidium salutare* con claves, descripciones, mapas, e ilustraciones. El complejo incluye *P. laruotteanum* (sin taxa subspecíficos adicionales) y *P. salutare* (con un total de cinco variedades). Este complejo se encuentra desde el este de Sur América templada hasta México y Centro América. Se seleccionan lectotipos para los siguientes taxa: *Calycolpus parviflorus* Sagot, *Myrtus acutata* O. Berg, *Myrtus blanchetiana* O. Berg, *Myrtus cuspidata* O. Berg, *Myrtus cuspidata* var. *tetramera* O. Berg, *Myrtus incana* O. Berg, *Myrtus mucronata* Cambess., *Myrtus nivea* O. Berg, *Myrtus pubescens* O. Berg, *Myrtus rigida* O. Berg, *Myrtus sellowiana* O. Berg, *Myrtus sericea* var. *fruticosa* O. Berg, *Myrtus suffruticosa* O. Berg, *Myrtus suffruticosa* var. *latifolia* O. Berg, *Psidium guayabita* A. Rich., *Psidium pohlianum* O. Berg, *Psidium salutare* var. *laxum* O. Berg y *Psidium salutare* var. *subalternum* O. Berg. Se hacen las siguientes combinaciones nuevas: *Psidium salutare* var. *decussatum* (DC.) Landrum, *Psidium salutare* var. *mucronatum* (Cambess.) Landrum, *Psidium salutare* var. *pohlianum* (O. Berg) Landrum, y *Psidium salutare* var. *sericeum* (Cambess.) Landrum.

Psidium (Myrtaceae) is a genus of at least 50 and perhaps as many as 100 species (McVaugh 1968) with a natural range from Mexico and the Caribbean to Uruguay and northern Argentina on the American continents and extending to some east Pacific islands (e.g. Galapagos). A few weedy and/or cultivated species have been spread by humans around the World to tropical and subtropical climates (e.g., *P. guajava* L., *P. cattleianum* Sabine). The great variance in estimates of numbers of species is due to complexes of entities that might themselves be considered single variable species or species groups. One such group is the

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Psidium salutare is complex, which ranges from Mexico to Uruguay and includes such commonly accepted species as *P. laruotteanum, P. salutare, P. luridum, P. incanum,* and *P. pohlianum.* The purpose of this paper is to treat the *P. salutare* complex, as it may be several years before a monograph of the whole genus will be completed.

Psidium is distinguished from other genera by a combination of floral and seed characters discussed in Landrum and Sharp (1989), namely, flowers 5-merous with multiovulate locules; placenta often peltate; seed coat rough or dull, not lustrous, covered with a pulpy layer when wet; hard portion of seed coat (5–)8–30 cells thick at narrowest point, the cells thick-walled, elongate, overlapping. The *P. salutare* complex is differentiated from other species of the genus by 1) a usual habit of subshrub or shrub (but reaching tree size in some populations); 2) a habitat mainly of grasslands or low shrubby growth (cerrado) that is frequently burned; 3) an ability to sprout back from underground stems even after fires; 4) leaves with brochidodromous venation with a well marked marginal vein that closely follows the margin and tertiary veins that form a reticulate-dendritic pattern; 5) relatively small flower buds (4–9 mm) with the calyx open; and 6) a peltate placenta with one or two rows of ovules on the edge of the each lamina.

Another group of similar range (northern Argentina to Venezuela), habit, and habitat is the *Psidium cinereum* complex (*P. cinerum* DC., *P. grandifolium* DC., *P. australe* Cambess., *P. missionum* D. Legrand, and *P. suffruticosum* O. Berg). That complex differs in having leaves with brochidodromous venation (sometimes blending into acrodromous venation proximally) with a marginal vein that broadly arches between the laterals and thus does not closely follow the margin, relatively large flower buds (often over 1 cm long) with the calyx open or closed, and a non-peltate, only slightly protruding placenta with numerous irregular rows of ovules.

A third group that is sometimes confused with the *P. salutare* complex is the *P. oligosperma* DC. complex, which includes *P. sartorianum* (O. Berg) Nied. It differs in having the calyx closed or nearly closed and being shrubs to relatively large trees of woodland or forest habitats.

The great variability in the *Psidium salutare* complex is reflected in the numerous names that have been proposed, including at least 44 basionyms at the specific level and several more subspecific names. After several years of intermittent study of herbarium specimens and fieldwork I have concluded that the *P. salutare* complex is best considered two species: *P. salutare* and *P. laruotteanum.* I recognize *P. salutare* as containing five varieties that correspond closely with geographic regions that sometimes overlap. All the varieties recognized here have been recognized previously as species by other taxonomists, e.g., Berg (1857–1859), de Candolle (1828), Legrand and Klein (1977), and Rotman (1976). Because I often find specimens that are intermediate between the enti-

ties I recognize as varieties of *P. salutare*, I suspect that they freely interbreed when growing sympatrically. I strongly recommend accepting them at the varietal level but realize others may disagree. Thus, in the discussion of the nontypical varieties I indicate the name that the entity would have if recognized at the specific level.

For illustrations I have used portions of scanned herbarium specimens. These images can be viewed in their entirety in color in the Image Library on the ASU Herbarium website http://lifesciences.asu.edu/herbarium/. A list of exsiccatae will also be made available at the same website once this paper is published.

Ecology.—The species of *Psidium salutare* complex are similar in ecological preferences and often grow side by side (e.g., near Brasilia, Brazil). Both grow in fire-induced savannas or scrub vegetation (cerrado). Both sprout back from underground stems after fire or other disturbance. The climates in which they grow often have distinct dry and wet seasons, with freezing temperatures being rare or non-existent. Commonly associated with them are other genera of Myrtaceae, e.g., *Campomanesia*, *Eugenia*, and *Myrcia* and the vegetation is often dominated by Poaceae, Fabaceae, and Asteraceae.

KEY TO THE SPECIES AND VARIETIES OF THE *P. SALUTARE* COMPLEX

1. Young leaves densely covered with hairs beneath, the lower surface of the leaf often hidden.
   2. Leaves silvery lanate, usually less that 1.5 cm wide; apex usually sharply acute to abruptly acuminate; hairs of leaves of two lengths, short and tangled and long and nearly straight; Argentina, Uruguay, Bolivia, Paraguay, Rio Grande do Sul (Brazil). _____ **P. salutare** var. **sericeum**
   2. Leaves yellowish to grayish short tomentose, often over 1.5 cm wide; apex acute to rounded; hairs of leaves uniform in length, all tangled; Paraguay, Bolivia, Paraná (Brazil), north to Venezuela and Costa Rica. _____ **P. laruotteanum**
1. Young leaves glabrous to moderately pubescent beneath.
   3. Venation clearly evident above and below, the marginal vein within 1 mm of the margin; leaves often narrowly elliptic or lanceolate, often 3 or more times as long as wide, often lustrous; leaf apex often apiculate; calyx lobes longer than calyx tube plus hypanthial tube; Argentina, Uruguay, Paraguay, Rio Grande do Sul, Santa Catarina, Paraná. _____ **P. salutare** var. **mucronatum**
   3. Venation clear y evident or not, the marginal vein usually more than 1 mm from the margin; leaves mostly less than 3 times as long as wide, lustrous or not; leaf apex usually without an apiculum; calyx-lobes longer or shorter than calyx tube plus hypanthial tube.
      4. Leaves narrowly elliptic to elliptic, mostly less than 1.5 cm wide, the apex usually rounded; peduncle 0.5–1.5 cm long; Paraná to Goiás. _____ **Psidium salutare** var. **decussatum**
      4. Leaves various, often lanceolate, usually over 2 cm wide, the apex often acute; peduncle 0.4–3 cm long; Paraguay to Mexico and Caribbean.
         5. Leaves 4–9 cm long, 2–5 cm wide, elliptic to obovate; usually shrubs to small trees; plants glabrous; central Brazil, Bolivia to Venezuela. _____ **Psidium salutare** var. **pohlianum**

5. Leaves 3.3–7 cm long, 1–3.3 cm wide, usually lanceolate, ovate, or elliptic; normally subshrubs; plants glabrous or pubescent; Paraguay to Mexico and Caribbean. _____ **Psidium salutare** var. **salutare**

Psidium laruotteanum Cambess., in Saint-Hilaire Bras. merid. 2:282. 1833. (**Figs. 1, 3**). TYPE: BRAZIL: "Prope Alto da Varginha (prov. Minas Geraes)," *Saint-Hilaire s.n.* (HOLOTYPE: P!, = F-36412!, = ASU photo!).

Psidium aerugineum O. Berg, in Mart., Fl. bras. 14(1):391. 1857. TYPE: BRAZIL: "in campis prov. Rio Grande do Sul," *Sellow s.n.* (HOLOTYPE: B, lost; ISOTYPE: LE, = ASU photo!).

Campomanesia suffruticosa O. Berg, in Mart., Fl. Bras. 14(1):448. 1857. TYPE: BRAZIL: "in prov. Ceara," syntypes: *Gardner 1611 & Gardner 1610* in "hb. Vindob. et Mart." LECTOTYPE: *Gardner 1611* W! (designated lectotype by Landrum, 1986). ISOLECTOTYPES: BR!, K!, G, = F-23367!. SYNTYPE: *Gardner 1610* W!, ISOSYNTYPES K!, S!, US!,).

Psidium basanthum O. Berg, in Mart., Fl. bras. 14(1):601. 1859. TYPE: BRAZIL: "prope Paracatu et Mugi prov. S. Pauli," *Riedel s.n.* (HOLOTYPE: LE, = ASU photo!).

Psidium glaucescens O. Berg, in Mart. Fl. bras. 14(1):600. 1859. TYPE: BRAZIL: "Serra da Chapada prov. Minarum," *Riedel s.n.* (HOLOTYPE: LE,= ASU photo!; ISOTYPE: P!, = F-36410!).

Psidium aerugineum var. *angustifolium* O. Berg, in Mart., Fl. bras. 14(1):601. 1859. TYPE: BRAZIL: (HOLOTYPE: LE; probable HOLOTYPE = ISOTYPE of *Psidium aerugineum*).

Myrtus bergiana Nied., in Engl. & Prantl, Naturl. Pflanzenfam. 3, Abt. 7:66. 1893. New name for *Campomanesia suffruticosa* O. Berg.

Psidium warmingianum Kiaersk., Enum. Myrt. bras. 28. 1893. New name for *Campomanesia suffruticosa* O. Berg.

Psidium warmingianum var. *verticillata* Kiaersk., Enum. Myrt. bras. 28. 1893. TYPE: BRAZIL: "Lagoa Santa," *Lund & Warming s.n.* (HOLOTYPE: C).

Psidium savannarum Donn. Sm., Bot. Gaz.:244. 1897. TYPE: COSTA RICA: "Savana at Buenos Ayres, Comarca de Puntarenas," *Tonduz CR-4033* (HOLOTYPE: CR; ISOTYPE: BR!).

Psidium bergianum (Nied.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 15:485. 1941.

Myrtus formosus Barb. Rodr., Myrt. Paraguay 16. 1903 TYPE: PARAGUAY: "Ipe hu....Sierra Maracayu," *Hassler 5079* (HOLOTYPE: G!, = ASU photo!).

Psidium capibaryense Barb. Rodr. ex Chodat & Hassl., Bull. Herb Boissier 7:797. 1907 TYPE: PARAGUAY: "pr. Vaqueria Capibary," *Hassler 4387* (HOLOTYPE: G!, = ASU photo!)

Psidium quinquedentatum Amshoff, Recueil Trav. Bot. Neer. 39:164. 1942 TYPE: SURINAM: "Upper Sipaliwini R. near Brazilian frontier," *Rombouts, H. E. 329* (HOLOTYPE: U; ISOTYPES, MO!, NY!).

Shrub up to ca. 1.5 m high, often less than 0.5 m high, with new shoots arising from a woody subterranean base or rhizome, densely tomentose to sparsely pubescent over most surfaces; hairs to ca. 1.5 mm long, grayish, yellowish-white, to rusty, usually curled and tangled; young twigs usually densely tomentose, remaining so for more than 1 year, the bark of older twigs becoming rough and scaly. **Leaves** normally opposite (rarely in whorls of 3, or spirally arranged) obovate, oblanceolate, elliptic, or oblong, 3–9 (–11) cm long, 1.6–4.5(–6) cm wide, 1.6–3.2 times as long as wide; apex rounded, acute, or acuminate; base obtuse to cuneate; petiole 0–2 mm long, ca. 2 mm wide, tomentose; midvein flat or slightly raised above, prominent below, usually more densely hairy above than surrounding blade, the venation brochidodromous with 7–13 pairs of lateral veins, these weak to prominent, slightly raised above in mature leaves, ascending at an angle



FIG. 1. *Psidium laruotteanum*. **A,** *Ribas & Pereira 1812* (ASU), young branch of 0.7 m shrub; note large leaves. **B & C,** *Hatschbach 53638* (ASU). **B,** middle portion showing full stature of plant with new growth arising from ground level stem; **C,** close view of flowers.

of ca. 45 degrees, nearly straight, joining an equally prominent, shallowly arcing marginal vein near (1–2 mm) the margin, the tertiary veins weaker, alternating with the laterals, branching, arising from the marginal vein; blades stiffly coriaceaous at maturity, drying gray-green to reddish-brown (under hairs), the lower surface usually densely tomentose, the upper surface usually sparsely to moderately pubescent. **Flower bud** ovoid to pyriform, 4–9 mm long; peduncles solitary in the axils of leaves or bracts, 0.2–3 cm long, 1–1.5 mm wide, normally uniflorous (rarely triflorous), densely pubescent; bracteoles linear to narrowly elliptic, 5–8 mm long, 1–1.5 mm wide, densely pubescent, caducous at about

anthesis; calyx open, prolonged ca. 1 mm beyond the ovary summit, the lobes about triangular, 1–4 mm long, 1–3 mm wide, densely pubescent within and without, sometimes less pubescent than the hypanthium; petals suborbicular to obovate, 8–10 mm long, subglabrous; hypanthium funnel-shaped, 2–5 mm long, densely tomentose; disk ca. 4 mm across; stamens 70–200, 5–9 mm long; anthers suborbicular, 0.5–1 mm long; style 6–8 mm long; ovary (2–)3(–4)-locular; ovules 7–19 per locule, reflexed, usually uniseriate on the margin of a peltate placenta. **Fruit** subglobose, 1.2–2 cm long; seeds 5–20, more or less rounded, 4–7 mm long.

Representative specimens. **BOLIVIA. Santa Cruz:** Velasco Prov., P. N. Noel Kempff M., Campamento Las Gamas (14°48'52"S, 60°24'08"W), 900 m, 1 Nov 1995 (fr), *Killeen & Grinwood 7819* (ASU).

BRAZIL. Distrito Federal: ca. 20 km NE de Brasilia na estrada Brasilia/Fortaleza, 20 Sep 1967 (fl), *Haas Sr. et al 69* (HB); Plano Piloto, Brasilia D.F., 20 Sep 1962 (fl), *Heringer 9007* (HB, NY); Horto do Guara Brasilia D.F., 5 Jan 1962 (fr), *Heringer 881021* (HB); Jardim Botânico de Brasilia (15°52'S, 47°50'W), 1070 m, 31 Aug 1995 (st), *Poença et al. 1444* (ASU, UB); Chapada da Contagem, road NE edge of P. N. de Brasilia, Rua 4, 1160 m, 10 Sep 1995 (fl), *Proença et al. 1456* (ASU, UB); entre Sobradinho/Planaltina, KM 20, 3 Sep 1995 (st), *Proença et al. 1473* (ASU, UB); Samambaia, Parque Boca da Mata, 3 Sep 1995 (fr), *Rezende 186* (ASU); S side of Campus, 16 Nov 1977 (fr), *Universidade de Brasilia, Taxonomy Class 552* (US). **Goiás:** Rod. GO-118, 5–8 km a W de Alto Paraíso, 1200 m, 16 Oct 1990 (fl), *Hatschbach 54613* (ASU); São João da Alianca, 30 Oct 1979 (fr), *Heringer 2650* (NY); Cidade Ecletica (50 km de Brasilia), 10 Nov 1973 (fl), *Heringer 12962* (NY, UB); Serra dos Pireneus, ca. 20 km E of Pirenopolis, 1000 m, 16 Jan 1972 (fr), *Irwin et al. 34281* (NY); Mun. de Mineiros (17°28'S, 52°31'W), 800 m, 12 Dec 1983 (fr), *Magnago 334* (HRB); Cristalina, ca. 2 km N of turnoff to Cristalina on highway to Brasilia, 1150 m, 9 Sep 1995 (st), *Proença et al. 1447* (ASU, UB); Padre Bernardo, 10 km S de Brazlandia (15°43'S, 48°12'W), 13 Nov 1990 (fr), *Viera et al. 610* (ASU). **Mato Grosso:** Chapada dos Guimaraes, just above Cachoeira Furada, Reserva Buriti, 720 m, 12 Oct 1973 (fl), *Prance et al. 18827* (NY); Alto do Araguaia, 15 km NO de Alto do Araguaia na estrada para Itiquira (17°15'S, 53°21'W), 18 Sep 1996 (st), *Proença et al. 1526* (ASU, UB). **Mato Grosso do Sul:** Brasilandia, proximidade do rio Pardo (21°40'30"S, 52°40'W), 23 Oct 1981 (fl), *Dambros 215* (HRB); 6 km N pov. Agua Clara margen esq. estr. que liga Faz. Unifl ora, Gema e outras (20°24'S, 52°55'W), 12 Nov 1981 (fr), *Guimaraes 1339* (HBR, RB); a 6 km do Posto São Sebastiao - Tres Lagoas (20°05'S, 51°51'W), 26 Jan 1982 (fr), *Guimaraes 1367* (HBR, RB), Camapuã, Capão Redondo, 11 Nov 1973 (fl), *Hatschbach 33063* (MBM); Coxim, Reserva do Exército (18°30'S, 54°42'W), 19 Sep 1996 (st), *Proença et al. 1550* (ASU, UB). **Minas Gerais:** Rodov. Brasilia - Belo Horizonte, Paracatú, 3 Jun 1960 (fl), *Heringer 7566* (UB); Serra do Espinhaco, ca. 48 km W of Montes Claros, 950 m, 25 Feb 1969 (fr), *Irwin et al. 23866* (MO, NY); Morro das Pedras, ca. 37 km NE of Patrocinio, 1000 m, 29 Jan 1970 (fr), *Irwin et al. 25604* (NY); Serra do Cipó, between Veu da Noiva and Alto do Palacio (ca. 19°15'S, 43°40'W), 1000–1400 m, 31 Jan 1982 (fr), *Landrum 4242* (MBM, NY); entre Cruzilha e Mindurim, 27 Nov 1967 (fr), *Mattos 15225* (SP); prox. ao Horto Florestal, 27 Nov 1940 (fl), *Occhioni s.n.* (RB); Diamantina, rd. to São João da Chapada, 17 km NW of jct. with rd. from Curvelo-Diamantina, 1180 m, 23 Nov 1985 (fr), *Thomas et al. 4868* (ASU). **Paraná:** Parque Vila Velha, Mun. Ponta Grossa, 850 m, 4 Oct 1963 (fl), *Hatschbach 10234* (MBM); Chapadao S. Antonio (Mun. Arapoti), 11 Oct 1968 (fl), *Hatschbach 19977* (MBM); Rio S'Ana, Mun. Cerro Azul, 6 Oct 1977 (fl), *Hatschbach 40353* (HRB); Mun. Senges, Rod. PR-11, prox, km 252, 18 Nov 1989 (fl), *Hatschbach 53638* (ASU). **São Paulo:** Botucatu, 14 km E of São Manuel (22°45'S, 48°25'W), 550 m, 2 Nov 1973 (fl), *Gottsberger 11–21173* (ASU); Mun. Moji-Guaçu: Faz. Campininha, 9–11 km NNW de Padua Sales, 28 Sep 1960 (fr), *Mattos 8339* (SP); 3 km ao sul de Pilar do Sul, estado de São Paulo, 21 Oct 1966 (yfl), *Mattos 14088* (SP); Itararé, campos de São Pedro na Serra de Bom Sucesso, Faz. Ventania, 1000 m, 21 Oct 1966 (fr), *Mattos 14119* (SP); estrada Itararé - Itapeva, a ponte do Rio Verde (24°05'06"S, 49°12'06"W), 14 Nov 1994 (fr), *Souza et al. 7244* (ASU).

COSTA RICA. Puntarenas: on road to Salitre, ca. 2 km from Buenos Aires, ca. 500 m, 11 Sep 1989 (st), *Landrum 6560* (ASU); Buenos Aires de Osa, Barrio el Carmen, 22 Jul 1987 (fl), *Sanchez & Poveda 1260* (MO).

GUYANA. Pakaraima Mts., near base of Malakwalai-Tipu (4°48'N, 60°12'W), 700 m, 9 Jul 1994 (fr), *Henkel & Chen 5522* (ASU).

PARAGUAY. Canindeyu: Ygatimí, Reserva Natural del Bosque Mbaracayú, Nandurocai (ca. 24°20'S, 55°40'W), 19 Nov 1995 (st), *Landrum 8860* (ASU, FCQ).

VENEZUELA. Bolivar: Santa Elena de Uairén, 2–4 Mar 1972 (fl), *Bunting & Holmquist 4764* (NY); Roscio, ca. 3 km NW de San Ignacio de Yuruani (5°01'N, 61°8'W), 900 m, 20 Jun 1983 (fr), *Huber & Alarcon 7512* (MO, NY, VEN). **Zulia:** Sierra de Perijá, above Pishikakao, 400–1850 m, 1–3 Apr 1972 (fl), *Steyermark et al. 105766* (MICH).

Psidium rufum DC. (= *P. widgrenianum* O. Berg), which ranges from Paraná to Goiás and Bahia, is sometimes confused with *P. laruotteanum*. They are contrasted in the key below.

1. Shrub usually no more than 1.5 m high; hairs grayish, yellowish, or reddish brown, usually curled and tangled, obscuring the lower leaf surface; midvein and lateral veins flat or slightly raised above; petiole 0–2(–3) mm long; calyx lobes triangular or subtriangular, 1–4 mm long. ____ **P. laruotteanum**

1. Shrub or tree to 8 m high; hairs mainly reddish brown, mostly erect, usually not obscuring the lower leaf surface; midvein and often lateral veins impressed above; petiole (2–)3–9 mm long; calyx-lobes mainly broadly rounded, 0.5–2 mm long (rarely triangular and up to 4 mm long). ____ **P. rufum**

Psidium laruotteanum is variable as to leaf size and shape (Fig. 1). Smaller plants, especially new sprouts, tend to have small elliptic leaves and larger plants tend to have large oblanceolate or obovate leaves. Since a similar pattern is seen throughout the range, I do not suspect a genetic basis for this difference.

Berg cites the type of *Psidium aerugineum* var. *angustifolium* as being at LE but cites no collector or locality. A specimen at LE, collected by Sellow, annotated by Berg as *Psidium aerugineum*, I considered to be an isotype of that taxon. I suspect that this same specimen is the holotype of *Psidium aerugineum* var. *angustifolium*, but it was never annotated by Berg as such. It has relatively narrow young leaves, which Berg mentions in the protologue of var. *angustifolium*. I have found two other cases where Berg described a taxon at LE but seems not to have annotated a specimen (*Psidium riedelianum* O. Berg, in Mart., Fl. bras. 14(1):602. 1859) and *P. pohlianum* var. *brevipes* discussed below under *P. salutare* var. *pohlianum*.

Psidium salutare (H.B.K.) O. Berg, Linnaea 27:356. 1856. *Myrtus salutaris* H.B.K., Nov. gen. sp. 6:132. 1823. TYPE: "Carichanam, ad ripam Orinoci," *Humboldt & Bonpland s.n.* (HOLOTYPE: P, = F-36905!; ISOTYPE: B, =B1263/11 photo at MICH!).

Subshrub or shrub up to ca. 1.5 m high (often less than 0.5 m high), with new shoots arising from a woody subterranean base or rhizome, with shoots often short lived, or in one variety sometimes reaching tree size (up to 10 m high), glabrous, glabrous except for disk and calyx-lobes within, or sparsely to mod-

erately pubescent on young growth, or silvery lanate in one variety; hairs when present whitish, 0.3–1 mm long; young twigs glabrous to densely pubescent, reddish-brown, becoming grayish, the older bark gray to reddish-brown, becoming flaky. **Leaves** opposite or alternate on some shoots (rarely ternate), ovate, lanceolate, elliptic, narrowly elliptic, obovate, oblanceolate, (1–)2–9 cm long, 0.6–5.5 cm wide, 1.4–5 times as long as wide, the margin entire to somewhat revolute; apex obtuse, acute to acuminate, abruptly acuminate, sometimes apiculate; base cuneate, obtuse, or rounded; petiole 0–2 mm long, 1–1.5(–2) mm wide; midvein normally flat or slightly raised above, prominent below, the venation brochidodromous, with 5–12 pairs of lateral veins, these prominent to scarcely visible, leaving the midvein at an angle of ca. 45 degrees or less, nearly straight, joining a clear shallowly arcing, equally prominent marginal vein near (0.2–2 mm) the margin, the tertiary veins forming a dendritic pattern between the laterals; blades stiffly coriaceous at maturity, drying reddish-brown to gray-green, dull or lustrous above, the cellular pattern sometimes visible with a dissecting scope. **Flower buds** pyriform, 4–7 mm long; peduncles, axillary, uniflorous or triflorous, 0.4–3.5 cm long, 0.5–0.8 mm wide; bracteoles linear to lanceolate, deciduous or persisting, 2–9 mm long, 0.5–2 mm wide; calyx open, cup-like, tearing ca. 1 mm between the lobes at anthesis, the lobes broadly rounded to ovate-triangular, 0.5–5(–6) mm long, 2–3 mm wide, glabrous to lanate without, usually puberulent (less often glabrous) within; petals obovate to suborbicular, 5–11 mm long; hypanthium obconic to campanulate, 2–4 mm long, extended beyond the ovary summit ca. 1 mm; disk 3–4 mm across, puberulent or glabrous; stamens 100–200, 5–12 mm long; anthers subglobose to oblong, 0.3–0.8 mm long; style 5–8 mm long; ovary 2–3-locular; ovules 9–48 per locule, uniseriate or biseriate along edge of the placenta, this strongly to scarcely peltate. **Fruit** globose to subglobose, 8–10 mm in diam.; seeds 4–20, 4–8 mm long, subovoide.

Psidium salutare is a widespread and variable species. There are a few recognizable forms that correspond to geographic regions that I recognize as varieties, but the limits between these varieties are often unclear. Legrand and Klein (1977, p. 723) also noted difficulty in distinguishing these entities, but chose to retain them at the specific level. One might speculate that these morphological types represent adaptive syndromes of characters for somewhat different niches. In-depth studies of the entities, including population samples, field studies, estimates of genetic distinctness and exchange, and transplant experiments should prove interesting in the future, especially for sympatric varieties, e.g., var. *sericeum* and var. *mucronatum*, or var. *decussatum* and var. *pohlianum*. As recognized here, there is still considerable variation in var. *salutare* to which specimens unassignable to any of the other varieties are tentatively placed.

Psidium salutare var. **salutare**

Psidium salutare (HBK) O. Berg, Linnaea 27:356, as to type. 1856. (**Figs. 2E, 4, 5**).

Myrtus arayan HBK, Nov. gen. sp. 6:133. 1823. TYPE: PERU [ECUADOR]: "prope Gonzanamam Peruvianorum, ad ripam fluminis Catamayo," *Humboldt & Bonpland s.n.* (HOLOTYPE: P,= F-36874!).

Psidium ciliatum Benth., in Hook. J. bot. 2:318. 1840. TYPE: BRITISH GUIANA: "dry savannahs," *Schomburgk s.n.* (HOLOTYPE: K; ISOTYPES [*Schomburgk 365*], P!, = ASU photo!, W, = F-31434!).

Eugenia guayavillo Benth., Plantas Hartwegianas, 174. 1845. TYPE: MEXICO: "Popayan," *Hartweg 977* (HOLOTYPE: K, = ASU photo!).

Psidium guayabita A. Rich., Ess. Fl. Cub. 581. 1846. TYPE: CUBA: "Vuelta de Abajo," *J. M. Valenzuela s.n.*, (2 sheets at P!, ["TYPE" LECTOTYPE, here designated], = ASU photo!).

Psidium salutare var. *subalternum* O. Berg, Linnaea 27:357. 1856. TYPE: BRITISH GUIANA: "ad flumen Tacutu," *Rich. Schomburgk 498 & 1252; Rob. S. 365* (SYNTYPES B, lost; ISOSYNTYPES [*Schomburgk 365*], P! [LECTOTYPE, here designated], W, = F-31434!, = ASU photo!).

Psidium oerstedeanum O. Berg, Linnaea 27:360. 1856. TYPE: COSTA RICA & GUATEMALA: "Provincia Guanacaste (Oersted) & Rincón in Guatemala (Friedrichsthal)," *Oersted s.n. & Friedrichsthal 1226* (SYNTYPES W and "hb Oersted. no16"; SYNTYPE: C [*Oersted 4004*], = F-50931!).

Psidium salutare var. *laxum* O. Berg, Linnaea 27:357. 1856. TYPE: VENEZUELA: "Orinoco, ad Upata," *Otto 987* (HOLOTYPE: B, lost; ISOTYPE: LE [LECTOTYPE, here designated], = ASU photo!; possible ISOTYPE: W = F-31435!).

Psidium salutare var. *stricta* O. Berg, Linnaea 27:356. 1856. Inadmissible name to be replaced by *P. salutare* var. *salutare*.

Myrtus rigida O. Berg, in Mart., Fl. bras. 14(1):417 1857. TYPE: BRAZIL: "ad Paranapitanga distr. Itapeva in prov. S. Pauli," *Sellow s.n.* (HOLOTYPE: B, lost; ISOTYPE: P! [LECTOTYPE, here designated], = F-36443!, ASU photo!).

Myrtus blanchetiana O. Berg, in Mart. Fl. bras. 14(1):418. 1857. TYPE: BRAZIL: "Bahia," *Blanchet 3310* (HOLOTYPE: B, lost; ISOTYPES, W, G = F-23481!, P! [LECTOTYPE, here designated], = ASU photo!).

Myrtus sagraea O. Berg, Linnaea 30:710. 1860. TYPE: CUBA: without locality, *De la Sagra s.n.* (HOLOTYPE: P!, =ASU photo!).

Psidium lanceolatum O. Berg, Linnaea 30:704. 1861. TYPE: BRAZIL: without locality, (HOLOTYPE: P!, = ASU photo!).

Psidium guayabita var. *oblongata* Griseb., Cat. pl. Cub. 91. 1866. TYPE: CUBA: without locality, *Wright 2436* (HOLOTYPE: GOET; ISOTYPES, MICH!, MO!, NY!, = ASU photo!, P!).

Psidium guayabita var. *angustifolia* Griseb., Cat. pl. Cub. 91. 1866. TYPE: CUBA: without locality, *Wright 2436a* (HOLOTYPE: GOET).

Calycolpus parviflorus Sagot, Ann. Sci. Nat. (Paris) VI. 20:181. 1885. TYPE: FRENCH GUIANA: without locality, *Leprieur s.n.* (HOLOTYPE: P!, 2 specimens, ["TYPE" LECTOTYPE, here designated], = ASU photo!).

Psidium deltosepalum Barb. Rodr. ex Chodat & Hassl., Bull. Herb. Boissier 7:799. 1907. TYPE: PARAGUAY: "pr. Vaqueria Capibary," *Hassler 4400* (HOLOTYPE: G!, 3 specimens, =ASU photos!; ISOTYPES, NY!, P!).

Psidium valenzuelense Barb. Rodr. ex Chodat & Hassl., Bull. Herb. Boissier 7:798. 1907. TYPE: PARAGUAY: "pr. Valenzuela," *Hassler 6947* (HOLOTYPE: G!, 2 specimens; ISOTYPE: NY!).

Psidium arayan (HBK) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 15:484. 1941.

Psidium gentlei Lundell, Amer. Mid. Nat. 29 483. 1943. TYPE: BELIZE: TOLEDO DIST.: "Monkey River, Jenkins Creek," 1 Aug 1942 (fr), *Gentle 4062* (HOLOTYPE: MICH!; ISOTYPES MO!, NY!).

Myrcianthes reptans D. Legrand, Bol. Univ. Paraná Fac. Farm. 27:1–3. 1971. TYPE: BRAZIL: Paraná, "Mun. Palmeira, Faz. S. Amelia," *Hatschbach 17697* (HOLOTYPE: MVM; ISOTYPE: HB!, =ASU photo!).



FIG. 2. *Psidium salutare*, branchlets with leaves and flowers or young fruits. **A,** *Irwin et al. 10699* (NY), var. *decussatum*. **B,** *Landrum 3856* (NY), var. *mucronatum*. **C,** *Irwin et al. 9101* (NY), var. *pohlianum*. **D,** *Venturi 7582* (F), var. *sericeum*. **E,** *Burch 6180* (NY), var. *salutare*.

Usually a subshrub less than 0.5 m high; leaves elliptic, lanceolate, oblanceolate, ovate, or obovate, 3–7 cm long, 1–3.3 cm wide, 1.6–3.2 times as long as wide, glabrous to moderately pubescent; venation obscure to moderately pronounced, the marginal vein usually about 1 mm from margin; apex usually without an apiculum; peduncle 1–5 cm long, uniflorous or triflorous; calyx-lobes shorter or longer than the hypanthial tube plus calyx tube, acute to rounded.

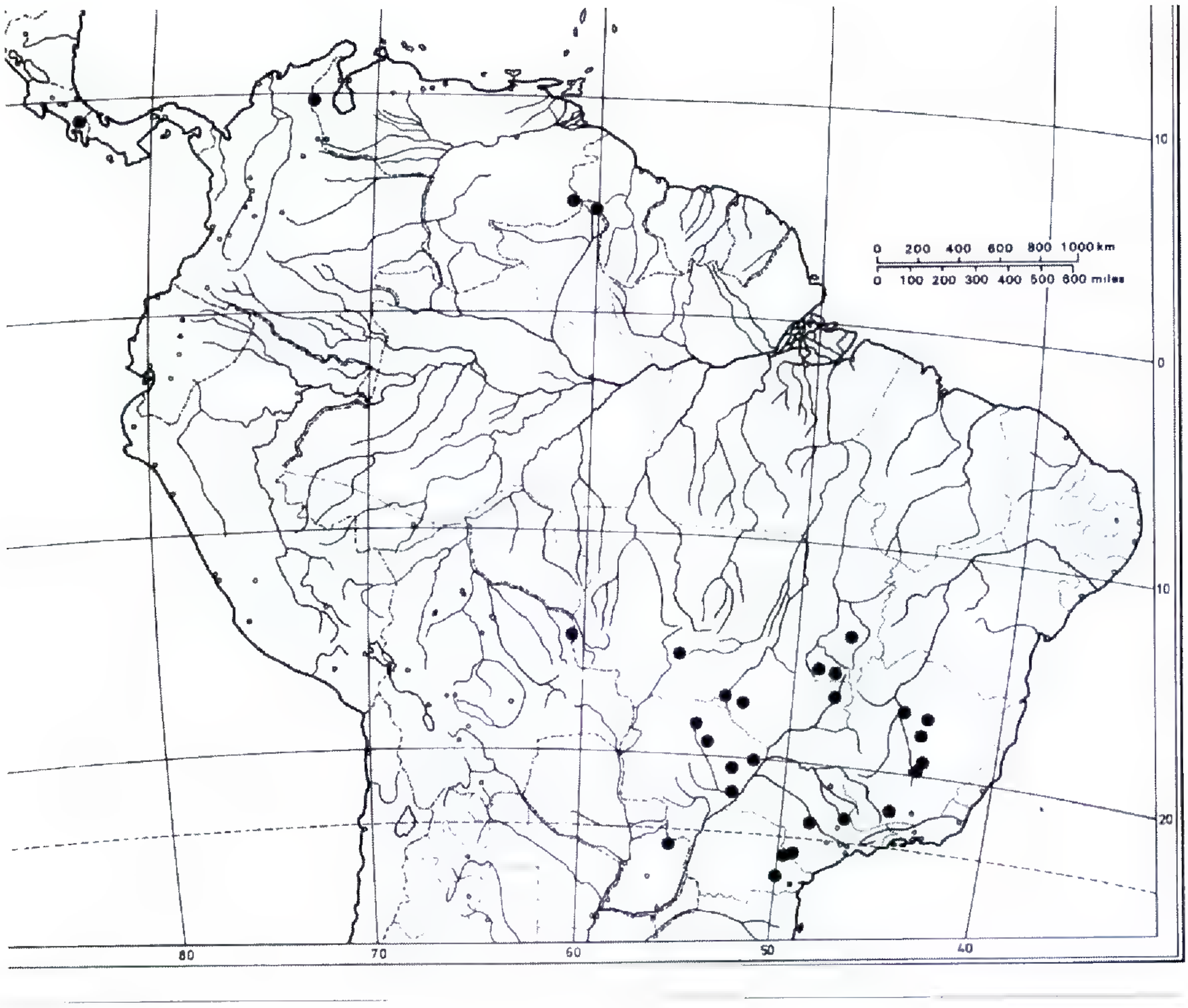


FIG. 3. Distribution of *Psidium laruotteanum*.

Representative specimens. **BELIZE. El Cayo:** Mountain Pine Ridge, San Agustin, Jul -Aug 1936 (fr), *Lundell 6560* (MICH, MO, NY); upper 200 m of Baldy Beacon, ca. 1000 m, 10 Jul 1970 (fr), *Spellman 1647* (MO).

BOLIVIA. Santa Cruz: P. N. Noel Kempff Mercado, Los Fierros (14°36'20"S, 60°51'30"W), 200 m, 26 Oct 1993 (fr), *Killeen et al. 5943* (ASU); P. N. Noel Kempff Mercado, 6 km NE del campamento Las Gamas (13°53'41"S, 60°48'46"W), 850 m, 28 Oct 1995 (fl), *Rodriguez & Surubí 549* (ASU).

BRAZIL. Ceará: Chapada do Araripe, ca. 15 km SW of Crato on BR-122 (7°30'S, 39°35'W), 860 m, 9 Jan 1983 (fl), *Plowman & Tavares Cacula 12704* (F). **Distrito Federal:** margem do lago Paranoa, 9 Nov 1978 (fr), *Heringer 701* (NY). **Goiás:** Corubaiba, Rio Corumba, Foz do Corrego (17°48'S, 48°21'W), 21 Sep 1993 (fl), *Da Silva et al. 1880* (SP); Serra do Caiapó, 35 km S of Caiaponia on road to Jatai (17°12'S, 51°47'W), 800–1000 m, 29 Oct 1964 (fl), *Irwin et al. 7552* (CAS); Serra dos Cristais, ca. 10 km W of Cristalina (17'S, 48'W), 1200 m, 4 Mar 1966 (fr), *Irwin et al. 13449* (MICH, MO, NY). **Mato Grosso:** Barra do Garças, 210 km along new road NNE of village of Xavantina, Corrego do Gato, ca. 450 m, 4 Oct 1968 (fl), *Eiten & Eiten 9058* (US); General Carneiro, Meruri [Meruré], Sep 1963 (fl), *Hartmann 369* (SP); 1 km NE of Garapú (13° 12'S, 52° 34'W), 300–400 m, 1 Oct 1964 (fl), *Irwin & Soderstom 6506* (MICH, MO, NY, RB); Mirassol D'Oeste, entre Cáceres e Pôrto Esperidiã, 23 Oct 1983 (fl), *Saddi 3477* (RB). **Minas Gerais:** São Gonçalo do Rio Preto, P. E. do Rio Preto (ca. 18°6'S, 43°20'W), 20 Feb 2002 (fr), *Lombardi 4583* (ASU); Beltim, Serra da Caveira, 1600 m, 11 Mar 1945 (fr), *Williams & Assis 6227* (MO). **Pará:** Martins Pinheiro, Campina do Mangaba, 28 Feb 1975 (yfr), *Coradin 141* (MICH); Maracaná, ca. 73 airline km NE of Castanhal, Martins Pinherio (0°52'S, 47°35'W), 50 m, 6 Apr 1980 (fr), *Davidse*

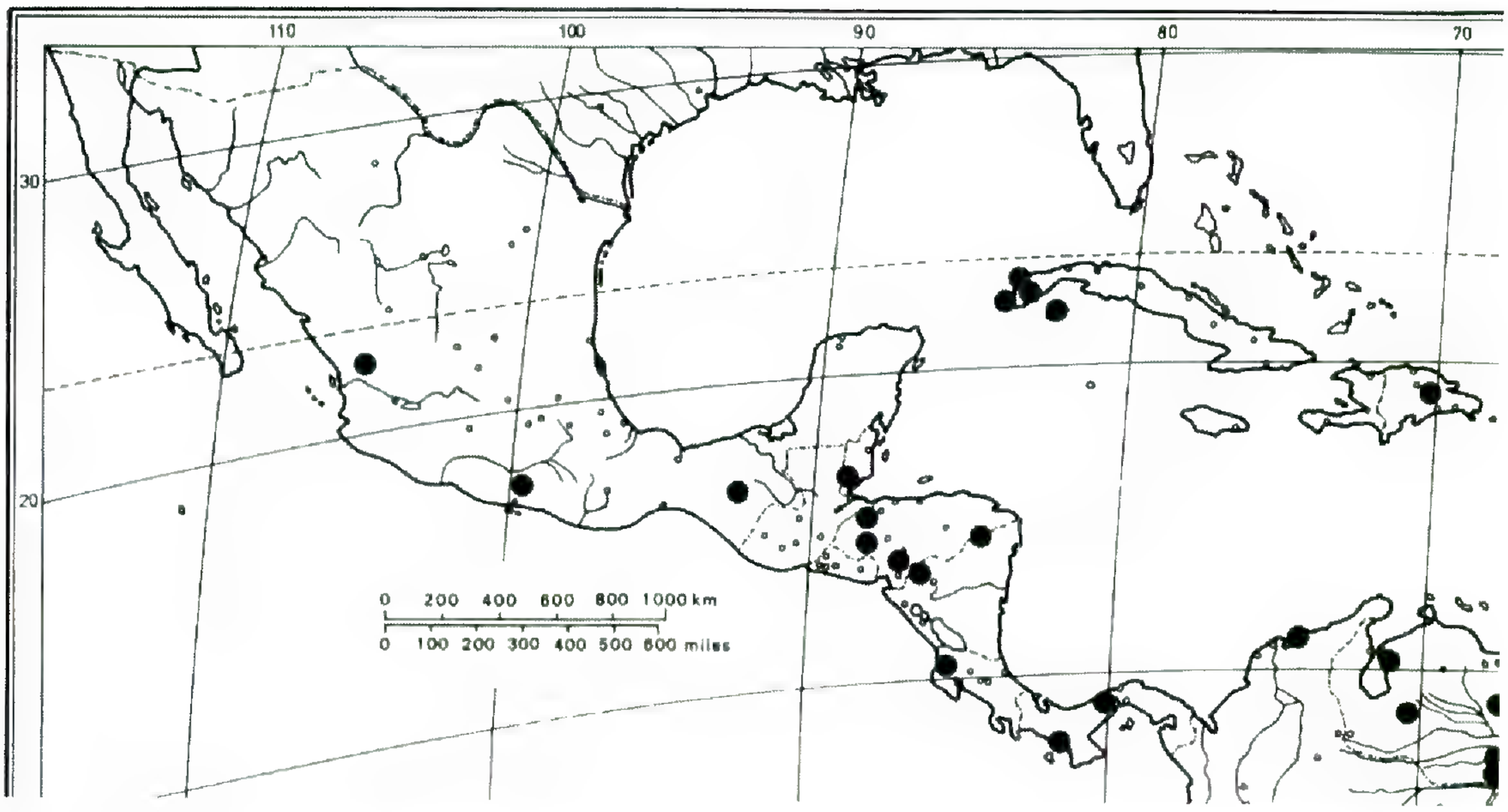


FIG. 4. Distribution of *Psidium salutare* var. *salutare* in northern part of range.

17923 (NY). **Paraná:** Lapa, Rio Passa Dois, 900 m, 5 Oct 1958 (fl), *Hatschbach 5048* (MBM); Palmeira, Rod. Do Café, Rio Tibagi, 780 m, 18 Nov 1962 (fl), *Hatschbach 9636* (MBM); Campo Mourã, 14 Oct 1965 (fl), *Hatschbach 12997* (MBM); Balsa Nova, Barra do Rio dos Papagaios, 14 Mar 1968 (fr), *Hatschbach 18749* (MBM); Ponta Grossa, Vila Velha, 7 Oct 1969 (fl), *Hatschbach 22326* (MBM); Guarapuava, Entre Rios, 21 Oct 1969 (fl), *Hatschbach 22551* (MBM); Jaguariaiva, Lageado 5 Reis, 18 Sep 1975 (fl), *Hatschbach 37098* (MBM); Alm. Tamandaré Rodovia dos Minerios, Rio Barigui, 9 Feb 1982 (fl), *Hatschbach 44564* (MBM); Palmeira, Faz. Santa Rita, ca. 65 km W of Curitiba (ca. 25°25'S, 49°50'W), 2 Dec 1981 (fl), *Landrum 3966* (MBM, NY); Rio Branco do sul, along road to Cerro Azul (ca. 25°S, 40°20'W), 7 Jan 1982 (fr), *Landrum 4112* (CAS, MBM, MICH, MO, NY). **Rio Grande do Sul:** Fazenda Faxinal, Arroio dos Ratos, 13 Apr 1982 (fl), *Hagelund 13890* (CTES). **Santa Catarina:** Campo Erê, 24 km W of Campo Erê (26° 22' S, 53° 11'W), 900–1000 m, 7 Dec 1964 (fl), *Smith & Klein 13826* (MICH, NY). **Tocantins:** Arraias, km 15–20 a W na rod. para Paranã, 10 Nov 1991 (fl), *Hatschbach 56024* (MBM).

COLOMBIA. Caqueta: San Vicente del Caguán, laguna "El Retorno," (74°17.0'W, 1°5.43'N), 265 m, 26 Jan 1990 (fl), *Betancur & Porras 1517* (MO). **Los Llanos:** Boyacá, La Comarca, ca. 15 km E of Barranca de Upia, 300 m, 12 Feb 1939 (fl), *Haught 2602* (MICH). **Sta. Marta:** Onaca, 2500 ft, 28 Aug 1898 (fl), *Smith 2509* (NY). Vichada: Parque Natural "El Tuparro," ca. 11 km NE of El Tapón on rd. to Centro Administrativo (5°12'N, 69°4'W), 18 Mar 1985 (fl), *Zarucchi & Barbosa 3749* (ASU).

COSTA RICA. Guanacaste: entre La Cruz et Liberia, 30 Jan 1909 (fl), *Brenes s.n.* (NY); Lomas Barbudal, Bagaces, 100 m, 10 May 1984 (fr), *Gomez & Herrera 23021* (ASU); 7 km NW of Bagaces, Comelco Ranch, 29 May 1971 (fl), *Heithaus 128* (MO); Santa Rosa National Park, across road from entrance (10° 53'N, 85° 35'W), 250–300 m, 28 Jun 1977 (fl), *Liesner 2700* (MO); al norte de la ciudad de Liberia, camino al Parque Nac. Rincón de la Vieja, 2 Oct 1985 (fr), *Gomez 23687* (MO).

CUBA. Isla de la Juventud (Isla de Pinos): La Cañada, 16 Feb 1916 (fl), *Britton et al. 14401* (NY); Sierra de Los Caballos, 2 Mar 1916 (fl), *Britton 15160* (NY,US); near Nueva Gerona, 1904 (fl, fr), *Curtiss 350* (MO, NY, US). **Piñar del Rio:** vicinity of Herradura, 26 Aug 1910 (fr), *Britton et al. 6450* (NY); Piñar del Río to Viñales, 200 m, 12 Sep 1910 (fr), *Britton 7309* (NY); near el Guama, 9 Mar 1900 (fl), *Palmer & Riley 212* (US); Laguna Jovero to Laguna Herradura, 12 Dec 1911 (st), *Shafer 10922* (NY); Arroyo del Sumidero, 7–9 Aug 1912 (fl), *Shafer & Br. León 13680* (NY); San Juan y Martinez, 7 May 1988 (fl), *Urquiola et al. 4522* (ASU); Mantua, 8 Nov 1990 (fr), *Urquiola et al. 6678* (ASU).



FIG. 5. Distribution of *Psidium salutare* var. *salutare* in South America (open circles), and *P. salutare* var. *sericeum* (dots).

DOMINCAN REPUBLIC. Sanchez Ramirez: Cotuí, 6 Sep 1952 (fr), *Jimenez 2433* (MICH, US).

ECUADOR. Loja: Zambi, camino a Tablaso (3°55'S, 79°30'30"W), 1500 m, 18 Mar 1995 (st), *Eynden & Cueva 294* (ASU, QCA).

EL SALVADOR. Ahuachapan: 1923, *Padilla 633* (US).

GUATEMALA. Chiquimula: Volcán Ipala, near Amatillo, 900–1510 m, 25 Oct 1939 (fl), *Steyermark 30553* (NY).

GUYANA. Rupununi Northern Savana, Annai Hillside, stand 37, ca. 350 ft, 7 Oct 1963 (fl), *Goodland 926* (NY); Potaro-Siparuni, Pakaraima Mts., Tay-klay o Creek, upper Ireng River (4°50'N, 59°58'W), 650–825 m, 19 Jan 1993 (yfr), *Henkel 880* (ASU); 7 km SW of Aishalton, Boidkorodai Mt., S Rupununi Savana (2°25'N, 59°20'W), 220 m, 18 Nov 1993 (fr), *Henkel 3479* (ASU); Kanuku Mts., Rupununi R., Bush Mouth near Witaru Falls (3°4'N, 59°28'W), 90–120 m, 9 Feb 1985 (fl), *Jansen-Jacobs et al. 87* (ASU, MO); NE from Karasabai, to Yourora Creek (4°03'N, 59°30'W), ca. 100 m, 7 Mar 1989 (fr), *McDowell 2154* (ASU).

HONDURAS. Comayagua: Siguatepeque, Escuela Nacional de Ciencias Forestales, 26 May 1972 (fl), *Burch 6180* (EAP, MO, NY). **El Paraíso:** Guinope, 2.5 mi S of the intersection of El Zamorano-Morolica and Guinope rd (13°51'50"N, 86°58'43"W), 1370 m, 16 Jun 1994 (fl), *Davidse et al. 35004* (ASU); between Manzaragua and San Lucas, 1350 m, 22 Sep 1968 (fr), *Molina 22698* (EAP, NY); 10 mi S of Yuscarán, ca. 1700 ft, Jul 1962 (yfr), *Webster 12011* (MICH); 5 km E of Ojo de Agua, 760 m, 4 Sep 1946 (fr), *Williams & Molina 10484* (EAP, MICH, MO). **Gracias a Dios:** Caserio de Rus-Rus, vaguada de Río Rus-Rus, Jul 1977 (fr), *Nelson & Romero 4126* (EAP, MO). **Francisco Morazán:** road from Comayagua to Tegucigalpa, 6.7 km SW of Parque Aurora, near KM 27, ca. 1300 m, 27 Aug 1989 (fr), *Landrum 6480* (ASU); ca. 25 km NW of Tegucigalpa on road to Comayagua, ca. 1000 m, 27 Aug 1989 (fr), *Landrum 6520* (ASU).

MEXICO. Chiapas: Concordia, 543 m, 16 Jun 1945 (fl), Matuda 5905 (MO); Rocky plains, Monserrate, Jun 1925 (Fl), *Purpus 10306* (US). **Guerrero:** Agua del Obispo, 34 km W of Chilpancingo on road to Acapulco, ca. 900 m, 23 Jul 1989 (fr), *Landrum & Landrum 6338* (ASU, MEXU). **Nayarit:** Mina Esperanza Rosa Morada, (fl), *Ortega 6658* (US); foothills between Acaponeta y Pedro Pablo, 2 Aug 1897, *Rose 1950* (US). **Veracruz:** Ejido El Nigromante, 6 Oct 1971 (st), *Chavelas et al. 4230* (MEXU).

NICARAGUA. Chontales: Hda. Veracruz (12° 11–12'N, 85° 21–22'W), 120–475 m, 4–6 Aug 1983 (fl), *Stevens 22419* (MO). **Nueva Segovia:** Monte Rico, 5 km al NE de El Jicaro (13° 44'N, 86° 5'W), ca 705 m, 3 Sep 1984 (fr), *Moreno 24611* (MO)

PANAMA. Toboga Island, Gulf of Panamá, 0–250m, 20 May 1911 (fl), *Pittier 3581* (US). **Canal Zone:** Ancon Hill, Nov–Dec 1923 (fl), *Standley 26340* (MO, US). Chiriquí: Boquete, 4000 ft, 29 Jun 1938 (fl), *Davidson 835* (MO). **Panamá:** hills NE of Hacienda La Joya, 50–300 m, 9 Dec 1934 (fl), *Dodge et al. 16899* (MO); between Río Pacora and Chepo, 3 Apr 1969 (fl), *Dwyer 5101* (MICH).

PARAGUAY: Caaguazú: Ea. La Esmeralda, 11 Dec 1982 (fr), *Schinini 22902* (CTES, MICH).

VENEZUELA: Apure: Pedro Camejo, near mouth of Cano San Miguel (67°17'W, 6°33'N), 38 m, 29 Apr 1977 (fl), *Davidse & Gonzalez 12373* (MICH, MO); 11 km directly E of Paso de San Pablo, along banks of Río Capanaparo (67°39'W, 7°2'N), 45 m, 8–9 May 1977 (fr), *Davidse & Gonzalez 12953* (MICH, MO, VEN). **Bolivar:** Cedeño, Foráneo La Urbana, 30 m, 2 Feb 1989 (fl), *Cuello 743* (MO); Caroni, Puerto Ordaz (8°17'N, 62°55'W), 30 m, 20 Nov 1997 (fl), *Diaz & Marin 3384* (ASU); Mun. Asc. Farreras, Maripa-Aripao (7°29'N, 65°20'W), 80 m, Feb 1990 (fr), *Elcoro 686* (MO); Piar, Cerro Tomasote (7°48'N, 62°02'W), 540 m, May 1986 (fl), *Fernandez 2742* (MO); Represa Guri, 1–5 km S of dam (7°45'N, 63°0'W), 20–240 m, 1 Apr 1981 (fl), *Liesner & Gonzalez 11064* (ASU, MO, VEN); km 111 on Puerto Ordaz-Cerro Bolivar Railroad, 300–350 m, 26 Oct Chiguao (6°32'N, 63°8'W), May Jun 1987 (fl), *Stergios 11113* (MO); E of Miamo, Altiplanicie de Nuria, between Hato de Nuria and camp, 400 m, 23 Jan 1961 (fr), *Steyermark 88711* (NY, VEN); entre San Felix y Puerto Ordaz, opposite the Fabrica de Alfareria, 26 Jun 1964 (fr), *Steyermark 94291* (MICH). **Guarico:** Est. Biologica de los Llanos, ca. 12 km SE de Calabozo (8°56'N, 67°25'W), 75 m, 15 May 1987 (fr), *Ramirez 2182* (MO). **Mérida:** between Beguilla and Mucuchachí, 1065–2430 m, 4 May 1944 (fl, fr), *Steyermark 56312* (NY, VEN). **Portuguesa:** Llanos de Araure, 9 Apr 1925 (fl), *Pittier 11748* (NY). **Sucre:** Cumbre de Montaña de Mochima, 18 km SE de Cumana (10°20'N, 64°20'W), 350–400 m, 16 Sep 1973 (fr), *Steyermark et al. 108604* (MO, VEN). **Zulia:** Miranda, entre la via El Consejo-El Pensado y el Límite con el Edo. Falcón, 21 May 1980 (fl), *Bunting & Stoddart 9238* (NY).

Psidium salutare var. *salutare* (*P. salutare* in the traditional sense) is sometimes confused with *P. oligospermum* (=*P. sartorianum*). Their ranges are similar, both extending to central Mexico and the Caribbean and as far south as southeastern Brazil and Paraguay. They are compared in the key below.

1. Calyx open in the flower bud (closed corolla clearly visible); calyx lobes either evident or the margin of the calyx merely sinuate; subshrubs of open grasslands or scrub vegetation; petals 5–11 mm long; hairs when present ca. 0.5 mm long. _____ **P. salutare** var. **salutare**

1. Calyx closed in the flower bud (closed corolla hidden); calyx calyptrate or with terminal lobes (appearing puckered); shrubs to large trees, usually of forested habitats; petals 3–6 mm long; hairs when present up to ca. 0.2 mm long. _____ **P. oligospermum**

Psidium salutare var. *salutare* as understood here ranges from Paraguay to the Caribbean and Mexico and is quite variable. There are two local forms that might merit recognition as varieties: 1) Populations in Cuba have the calyx-lobes connate about 2–3 mm beyond the staminal ring; these have long gone under the name *P. guayabita*. 2) In Paraná to Rio Grande do Sul, Brazil and Paraguay there are populations with rather large elliptic to obovate, thinly pubescent leaves and include the types of *Myrcianthes reptans* and *Psidium valenzuelense*. Similar specimens occur in Central America, so it appears that *P. salutare* var. *salutare* is a morphologically flexible entity throughout its range.

Psidium salutare var. **decussatum** (DC.) Landrum, comb. nov. (**Figs. 2A, 6**). *Psidium decussatum* DC., Prodr. 3:235. 1828. TYPE: BRAZIL: "prov. Minarum," *Martius s.n.* (HOLOTYPE: M, = F-19710!, = ASU photo!).

Usually a subshrub less than 0.5 m high; leaves elliptic to narrowly elliptic, (1) 2–5.3 cm long, 0.7–1.7 cm wide, (1.5–)2.5–4.5 times as long as wide, glabrous (rarely sparsely pubescent); venation obscure, the marginal vein about 0.5 mm from margin; apex without an apiculum; peduncle 0.5–1.5 mm long, uniflorous (rarely triflorus); calyx-lobes shorter or about as long as hypanthial tube plus calyx tube, acute or rounded.

Representative specimens. **Distrito Federal:** 12 km W of Taguatinga, 1250 m, 26 Nov 1965 (fl), *Irwin et al. 10699* (NY); 2 km E of Lago Paranoá, DF-6, 1000 m, 26 Feb 1970 (fr), *Irwin et al. 26671* (NY); Chapada da Contagem, rd. NE edge Parque Nac. de Brasilia, Rua 4, 1160 m, 10 Sep 1995 (st), *Proença et al. 1458* (ASU, UB); ao lado da Reserva Biologica das Aguas Emendadas, 3 Sep 1995 (st), *Proença et al. 1496* (ASU, UB). **Goiás:** 10 km W of Cristalina (17°S, 48°W), 1200 m, 5 Mar 1966 (fr), *Irwin et al. 13548* (NY). **Minas Gerais:** Morro das Pedras, ca. 37 km NE of Patrocinio, 1000 m, 29 Jan 1970 (fr), *Irwin et al. 25600* (NY). **Paraná:** Colombo, Capivari, 4 Nov 1971 (fr), *Hatschbach 27711* (MBM); Rio Branco do sul, along road to Cerro Azul (ca. 25°S, 49°20'W), 7 Jan 1982 (fr), *Landrum 4110* (MICH, NY); Bocaiúva do Sul, Serra da Bocaina, 16 Jan 2001 (fr), *Ribas & Barbosa 3166* (ASU).

If this entity is recognized at the specific level the name *Psidium decussatum* DC. should be used. It seems to freely intergrade with var. *pohlianum* near Brasilia.

Psidium salutare var. **mucronatum** (Cambess.) Landrum, comb. nov. (**Figs. 2B, 6**). *Myrtus mucronata* Cambess., in Saint-Hilaire, Fl. Bras. merid. 2:295. 1833. TYPE: Saint-Hilaire s.n. "ad ripas fluminum Rio de la Plata et Uruguay in provincia Cisplatina," *Martius s.n.* (three specimens, P!, all marked as ISOTYPE, one= F neg. 36436!, [LECTOTYPE, here designated]).

Myrtus lurida Spreng., Syst. Veg. 2:480. 1825. TYPE: URUGUAY: "Monte Video," *Sello s.n.* (HOLOTYPE: B?, probably lost).

Myrtus pauciflora Cambess., in Saint-Hilaire, Fl. Bras. merid. 2:296. 1833. TYPE: "Encapamento do Ricao das galinhas in parte occidentali provinciae Cisplatinae," *Martius s.n.* (HOLOTYPE: P!, = F-36439!, = ASU photo!).

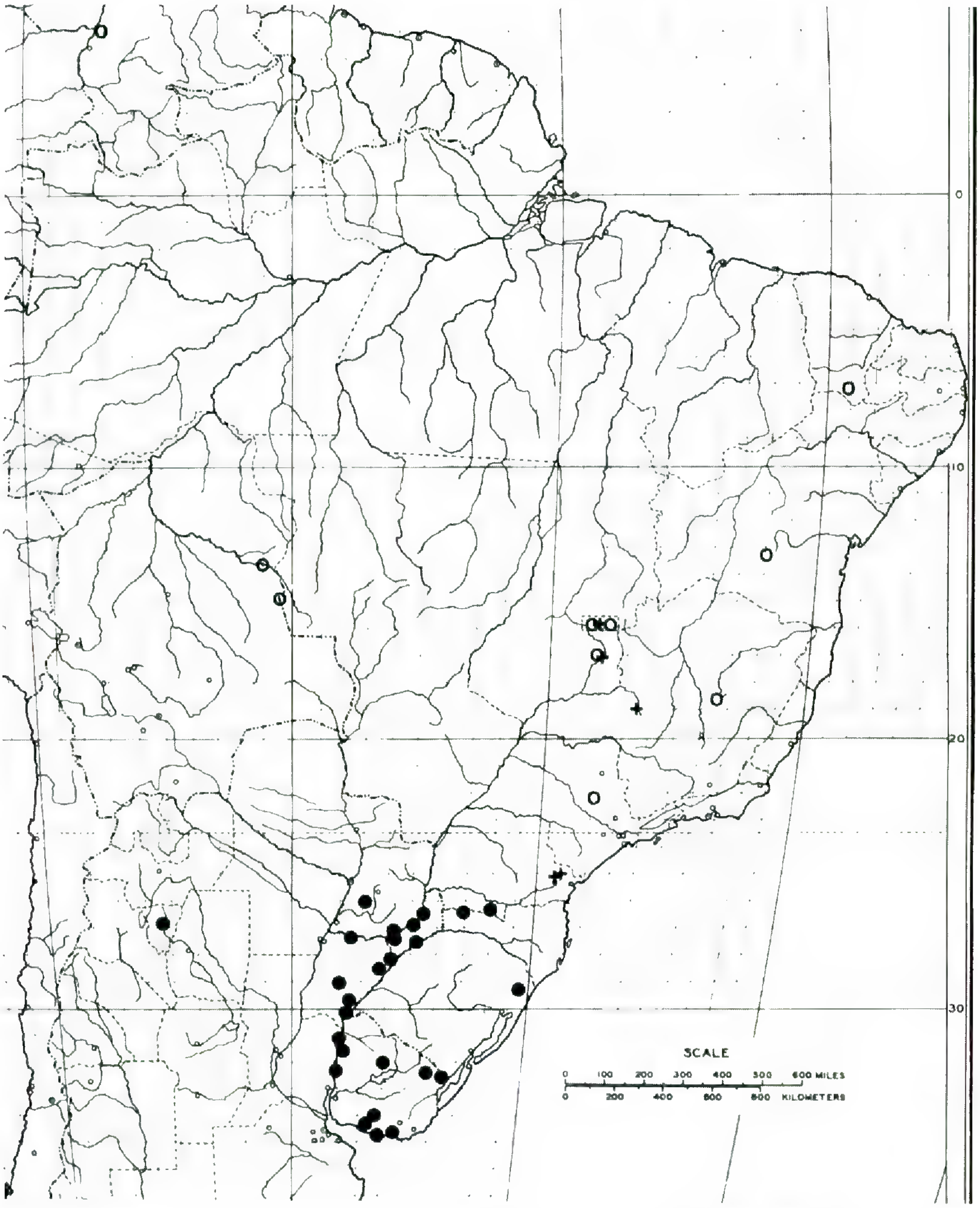


Fig. 6. Distribution of *Psidium salutare* var. *pohlianum* (open circles), *P. salutare* var. *decussatum* (crosses), and *P. salutare* var. *mucronatum* (dots).

Myrtus cuspidata O. Berg, in Mart., Fl. bras. 14(1):415. 1857. TYPE: URUGUAY: "in Montevideo," *Sellow s.n.* (SYNTYPES [types of the varieties] B, lost; ISOTYPE of *Myrtus cuspidata* var. *pentamera* at SGO! [LECTOTYPE, here designated], = ASU photo!).

Myrtus cuspidata var. *pentamera* O. Berg, in Mart., Fl. bras. 14(1):415. 1857. TYPE: URUGUAY: "in Montevideo," *Sellow s.n.* (HOLOTYPE: B, lost; ISOTYPE: SGO!, = ASU photo!). Name to be replaced with *Myrtus cuspidata* var. *cuspidata*.

Myrtus cuspidata var. *tetramera* O. Berg, in Mart., Fl. bras. 14(1):415. 1857. TYPE: URUGUAY: "in Montevideo," *Sellow* s.n. (HOLOTYPE: B, lost; ISOTYPE: SGO! [LECTOTYPE, here designated], = ASU photo!).

Myrtus mucronata var. *perforata* O. Berg, in Mart., Fl. bras. 14(1):416. 1857. Illegitimate name to be replaced by *M. mucronata* var. *mucronata*.

Myrtus mucronata var. *opaca* O. Berg, in Mart., Fl. bras. 14(1):416. 1857. TYPE: URUGUAY: "in Montevideo," *Sellow* s.n. (HOLOTYPE: B).

Myrtus ovalis O. Berg, in Mart., Fl. bras. 14(1):417 1857. TYPE: URUGUAY: "in Montevideo," *Sellow* s.n. (HOLOTYPE: B).

Myrtus suffruticosa O. Berg, in Mart., Fl. bras. 14(1):418 1857. TYPE: URUGUAY: "in Montevideo," *Sellow* s.n. (syntypes [types of the varieties] B, lost; ISOTYPE of *Myrtus suffruticosa* var. *latifolia* at P! [lectotype, here designated], = ASU photo!).

Myrtus suffruticosa var. *latifolia* O. Berg, in Mart., Fl. bras. 14(1):418. 1857. TYPE: URUGUAY: "in Montevideo," *Sellow* s.n. (HOLOTYPE: B, lost; ISOTYPE: P! [LECTOTYPE, here designated], = ASU photo!).

Myrtus suffruticosa var. *angustifolia* O. Berg, in Mart., Fl. bras. 14(1):419. 1857. TYPE: URUGUAY: "in Montevideo," *Sellow* s.n. (HOLOTYPE: B, lost).

Myrtus acutata O. Berg, in Mart., Fl. bras. 14(1):415. 1857. TYPE: URUGUAY: "in Montevideo," *Sellow* s.n. (HOLOTYPE: B, lost; ISOTYPES, P [two specimens] , one = F-36424! [LECTOTYPE, here designated]).

Myrtus sellowiana O. Berg, in Mart., Fl. bras. 14(1):413. 1857. TYPE: BRAZIL: "ad Tapanhoacanga prov. Minarum," *Sellow* s.n. (HOLOTYPE: B, lost; ISOTYPE: P!, = F-36445! [LECTOTYPE, here designated], = ASU photo!).

Psidium thea Griseb., Pl. lorentz. 91. 1874, and in Goett. Abh. 19:139. 1874. TYPE: ARGENTINA: "Cordoba, in monte Cerro negro pro. San Bartolo., Tucuman," *Hieronymus?* (HOLOTYPE: probably GOET; possible ISOTYPE: P = F-36422!).

Myrtus mucronata var. *thea* (Griseb.) Griseb. Abh. Konigl. Ges. Wiss. Gottingen 24:127. 1879.

Psidium luridum (Spreng.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 15:484. 1941.

Psidium pubifolium Burret, Notizbl. Bot. Gart. Berlin-Dahlem 15:484. 1941. New name for *Myrtus ovalis* O. Berg.

Psidium luridum var. cinereum Mattos, Loefgrenia 64:2. 1975. TYPE: BRAZIL: Santa Catarina, "Campo Erê, 17 km W of Campo Erê, ca. 26° 22'S, 53° 08' W, 900–1000 m," *Smith & Klein 13807* (HOLOTYPE: HBR, ISOTYPE: R!, = ASU photo!).

Psidium pubifolium f. nanum Rotman, Darwiniana 20:433. 1976. TYPE: BRAZIL. Santa Catarina, "Campo Erê, 37 km W of Campo Erê, ca. 26° 22'S, 53° 08'W, 900–1000m," *Smith & Klein 13807* (HOLOTYPE: MVM, ISOTYPE: R!, = ASU photo!).

Usually a subshrub less than 0.5 m high; leaves mostly narrowly elliptic to lanceolate, (1.5–)2–6 cm long, 0.7–2.3 cm wide, (1.4–)1.5–5 times as long as wide, glabrous to subglabrous, often lustrous; venation pronounced, raised on both surfaces, the marginal vein usually within 1 mm of the margin; apex apiculate; peduncle often over 2 cm long, uniflorous; calyx-lobes usually longer than hypanthial tube plus calyx tube, usually acute.

Representative specimens. **ARGENTINA. Corrientes:** 2 5 km de la ciudad de Monte Caseros, 28 Dec 1968 (fr), *Carnevali 1317* (CTES); Paso de Los Libres, Bonpland, costa río Uruguay, 19 Jan? 1945 (fr), *Ibarrola 2135* (NY); Santo Tomé, 33 km N de Santo Tomé, 27 Jan 1976 (fl), *Krapovickas & Cristobal 28934* (CTES, NY); Ituzaingó, Rincón Ombú Chico, 3–5 Jul 1974 (fl), *Krapovickas et al. 25477* (CTES, MICH); Mercedes a Itá Corá, Ayo. Pay-Ubre, dep. Mercedes, 2 Feb 1974 (fr), *Quarín & Gonzalez 2069*

(CTES); Berón de Astrada, 15 km W of Itá Ibaté, Ayo. Santa Isabel, 16 Jan 1977 (fl), *Schinini 14105* (CTES); Estación Experimental INTA, Dep. Empedrado, 7 Dec 1978 (fl), *Schinini 16225* (CTES); Co. Nazareno (Co. de Susini), 15 Feb 1979 (fr), *Schinini et al 17192* (CTES). **Entre Rios:** Santa Ana, dep. Federación, 15 Oct 1968 (fl), *Gomez Sosa 99* (CTES). **Misiones:** Posadas, Bonpland, 11 Jan 1908 (fl), *Ekman 2048* (MICH, NY); Candelaria, Bonpland, arroyo Martires Chico, 16 Jan 1976 (fl), *Krapovickas & Cristobal 28785* (CTES); Cainguás, Monte Carlo, 205 m, 2 Feb 1955 (fr), *Montes 14806* (NY); Apóstoles, 29 Jan 1948 (fr), *Schulz 6889* (CTES). **Tucumán:** Villa Nongues, Jan 1918 (fr), *Lillo 1351* (MO).

BRAZIL. Paraná: Palmas, Rio Chopim, 7 km abaixo da nascente, 20 Nov 1990 (fl), *Hatschbach 54810* (ASU, MBM). **Rio Grande do Sul:** São Francisco de Paula, (fr), *Rambo 30793* (MICH); Bom Jesus, Fazenda B. Velho, 4 Jan 1947 (fr), *Rambo 35177* (MO, NY).

PARAGUAY. Itapua: Arroyo Guazu Acatí, 15 Sep 1983 (fl), *Basualdo s.n.* (FCQ); Capitán Miranda, 4.2 km N of entrance to Hotel Tirol (ca. 27°12'S, 55°45'W), ca. 210 m, 13 Aug 1995 (st), *Landrum 8665* (ASU). **Paraguarí:** National Park Ybycuí, NE corner of the park on Arroyo Corrientes (26°03'S, 56°50'W), 21 Dec 1988 (fr), *Zardini et al. 9015* (PY).

URUGUAY. Artigas: ruta 30, 7 km S de Artigas, 10 Dec 1995 (fr), *Solis Neffa et al. 242* (CTES); Cerro Largo: S of Melo, 48 km, 9 Jan 1944 (fr), *Bartlett 21279* (MICH). **Maldonado:** Sierra de Animas, ca. 65 km E of Montevideo (ca. 34°45'S, 55°30'W), 22 Nov 1981 (fl), *Landrum 3856* (NY). **Montevideo:** Punta Espinillo, (fl), *Legrand 2710* (MICH); Chapicuy, orillas del río Uruguay, Sta Sofia, 15 Nov 1942 (fl), *Rosengurtt et al. B-4183* (MO, NY); Rocha: Santa Teresa, (fl), *Legrand MVM-1064* (MICH). **San José:** Rincón Gallinas, 5 m, Dec 1931 (fl), *Herter 88052* (NY, RB). **Tacuarembó:** Gruta de los Cuervos, 17 Jan 1944 (fr), *Legrand 3338* (NY).

There are many intermediates between typical var. *mucronatum* (which is glabrous) and typical var. *sericeum* (which is densely covered with silvery hairs). The fact that these varieties also have similar distributions, leads me to suspect that there is a simple genetic difference between them. Intermediates have mainly been identified as var. *sericeum*.

Psidium salutare var. *mucronatum* frequently grows with *P. missionum* and can easily be confused with that species. The two species are contrasted in the key below.

1. Leaves 2–4.5 cm long, 0.7–2.3 cm wide, 1.5–5 times as long as wide; marginal vein distinct, closely following the margin; placenta protruding, peltate; style 5–6 mm long, glabrous. _____ **P. salutare** var. **mucronatum**
1. Leaves 2.5–8.8 cm long, 1.1–4 cm wide, 1.8–3.5 times as long as wide; marginal vein evident only in distal portion of leaf, arching broadly between laterals; placenta protruding only slightly, not peltate; style 7–9 mm long, usually with a few scattered hairs. _____ **P. missionum**

If the entity here called *Psidium salutare* var. *mucronatum* is recognized at the specific level, the name *P. luridum* (Spreng.) Burret should be used. There may be no type specimen of *Myrtus lurida* in existence, having been at B and now destroyed. Burret (1941), who studied the type shortly before it was destroyed, listed *Myrtus cuspidata* as a synonym. That coupled with Sprengel's protologue leave little doubt as to its identity. The type of *Myrtus ovalis* at B was also destroyed, but the protologue is sufficient to consider it a synonym of this variety.

Psidium salutare var. **pohlianum** (O. Berg) Landrum, comb. nov. (**Figs. 2C, 6**).

Psidium pohlianum O. Berg, in Mart. Fl. bras. 14(1):390. 1857. TYPE: BRAZIL: "ad S.

Luzia in prov. Goyazensi," *Pohl 913*, *Sellow s.n.* (SYNTYPES B, lost; SYNTYPE [*Pohl 913*], W, = F-31431!; ISOSYNTYPE [*Sellow s.n.*], P!, [LECTOTYPE, here designated], = ASU photo!).

Psidium pohlianum var. *brevipes* O. Berg, in Mart., Fl. bras. 14(1):601. 1859. TYPE: BRAZIL: "prope S. Carlos prov. S. Pauli," *Riedel s.n.* (apparent HOLOTYPE 2 sheets at LE, =ASU photos!).

Shrub or tree to 10 m high; leaves mostly elliptic, to obovate, or oblanceolate, 4–9 cm long, 2–5.5 cm wide, 1.4–2.7(–3.5) times as long as wide, glabrous; venation pronounced, raised on both surfaces, the marginal vein usually about 1 mm from the margin; apex usually without an apiculum; peduncle 0.4–2 cm long, often triflorous; calyx-lobes shorter or about as long as hypanthial tube plus calyx tube, rounded to obtuse.

Representative specimens. **BOLIVIA. Santa Cruz:** P. N. Noel Kempff Mercado, Pista Las Gamas, (14°48'11"S, 60°23'35"W), 815 m, 9 Nov 1993 (fr), *Guillén & Centurión 1023* (ASU); P. N. Noel Kempff Mercado, 6 km SW del campamento Las Gamas (14°49'36"S, 60°23'10"W), 850 m, 30 Oct 1995 (fr), *Rodriguez & Surubí 592* (ASU); P. N. Noel Kempff Mercado, Huanchaca I, (13°53'55"S, 60°48'46"W), 850 m, 3 Nov 1995 (fr), *Rodriguez & Surubí 630* (ASU).

BRAZIL. Bahia: near Junco, ca. 15 km WNW of town of Rio de Contas (41°55'W, 13°32'S), 22 Jan 1974 (fr), *Harley 15596* (ASU, MICH). **Ceará:** Crato, Barreiro Grande- Agreste, 2 Apr 1995 (fr), *Silveira 22103* (RB). **Distrito Federal:** 10 km E of Planaltina, 1150 m, 10 Oct 1965 (yfr), *Irwin et al. 9101* (NY); Chapada da Contagem, rd. NE edge Parque Nac. de Brasilia, Rua 1, 1160 m, 1160 m, 10 Sep 1995 (fl), *Proença et al. 1455* (ASU, UB). **Goiás:** Serra dos Cristais, ca. 12 km E of Cristalina (17°S, 48°W), 1200 m, 9 Mar 1966 (fr), *Irwin et al. 13226* (CAS, MICH, NY); Serra dos Cristais, ca. 3 km W of Cristalina (17°S, 48°W), 1250 m, 3 Mar 1966 (fr), *Irwin et al 13367* (CAS, NY). **Minas Gerais:** Palacio, Serra do Cipó, 150 km N of Belo Horizonte, 1450 m, 20 Feb 1968 (fl), *Irwin et al. 20561* (F); 4 km N of Patrocinio, 1000 m, 31 Jan 1970 (fr), *Irwin et al. 25733* (NY). **São Paulo:** Itirapina, Estrada de Graúna, 2 Feb 1993 (fr), *Fabio de Barros 2515* (ASU).

VENEZUELA. Amazonas: Atures, ca. 30 km al N de Puerto Ayacucho y a unos 5 km al NE de Galipero (5°48'N, 67°20'W), 80 m, 9 May 1980 (yfr), *Huber 5210* (MICH, MO, NY, VEN); Atures, Rincones de Chacorro, 30 km N de Puerto Ayacucho, 5 km NE de Galipero (5°48'N, 67°20'W), ca. 80 m, 27 Feb 1982 (fl), *Huber 6289* (MICH, MO, NY, VEN); Atures, road NE from Puerto Ayacucho, 27.5 km towards El Burro, 28 Apr 1984 (fr), *Plowman & Guanchez 13756* (CAS, F, MO, NY, RB). **Bolivar:** Río Parguaza, 13 Apr 1946 (fl), *Velez 2374* (US, VEN).

If the entity here called *Psidium salutare* var. *pohlianum* is recognized at the specific level , the name *Psidium pohlianum* O. Berg should be used. As mentioned above, this variety intergrades with var. *decussatum* in the vicinity of Brasilia.

Two specimens at LE fit the protologue of *Psidium pohlianum* var. *brevipes*, but are annotated by Berg as to species only. I assume these specimens to represent the holotype of var. *brevipes*. One specimen is mixed with a fragment of *P. guineense*.

Psidium salutare var. **sericeum** (Cambess.) Landrum, comb. nov. (**Figs. 2D, 5**).

Myrtus sericea Cambess., in Saint-Hilaire, Fl. Bras. merid. 2:295. 1833. TYPE: BRAZIL: "Capilha de Mercedes... provinciae Cisplatinae, necnon... Rincao de Saneloés ad ripam amnis Ibicuy in provincia Missionum," *Saint-Hilaire s.n.* (HOLOTYPE: P!, = F-36446!; ISOTYPE: P!, = ASU photo!).

Myrtus nivea O. Berg, in Mart., Fl. bras. 14(1):414. 1857. TYPE: URUGUAY: "ad P[...] dos Inforcados in Montevideo," *Sellow s.n.* (HOLOTYPE: B, lost; ISOTYPES P! [LECTOTYPE, here designated], =ASU photo!, W, = F-31405!).

Myrtus sericea var. *fruticosa* O. Berg, in Mart., Fl. bras. 14(1):414. 1857. TYPE: URUGUAY: "ad Cerro in Montivedeo," *Sellow s.n.* (HOLOTYPE: B; ISOTYPE: P! [LECTOTYPE, here designated], = ASU photo!).

Myrtus sericea var. *suffruticosa* O. Berg, in Mart., Fl. bras. 14(1):414. 1857. TYPE: BRAZIL: illegitimate name to be replaced by *M. sericea* var. *sericea*.

Myrtus incana O. Berg, in Mart., Fl. bras. 14(1):416. 1857. TYPE: BRAZIL: "ad Cassapava in Rio Grande do Sul," *Sellow s.n.* (HOLOTYPE: B; ISOTYPE: P! [LECTOTYPE, here designated], = ASU photo!).

Myrtus pubescens O. Berg, in Mart., Fl. bras. 14(1):415. 1857. TYPE: BRAZIL: "ad Andre' Ferrina," *Sellow s.n.* (HOLOTYPE: B; ISOTYPE: P! [LECTOTYPE, here designated], = F-36441!, = ASU photo!).

Psidium incanum (O. Berg) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 15:485. 1941.

Psidium niveum (O. Berg) Herter, Rev. Sudamer. Bot. 7:221. 1943.

Psidium tomentellum Burret, Notizbl. Bot. Gart. Berlin-Dahlem 15:485. 1941. New name for *Myrtus sericea* Cambess.

Usually a subshrub less than 0.5 m high; leaves elliptic, ovate, obovate, narrowly elliptic, oblanceolate to lanceolate, 2–7 cm long, 0.6–2.8 cm wide, 2–3.7 times as long as wide, densely covered with silvery gray hairs when young; venation pronounced under hair cover, the marginal vein usually within 1 mm of the margin; apex apiculate; peduncle often over 2 cm long, uniflorous; calyx-lobes usually longer than hypanthial tube plus calyx tube, usually acute.

Representative specimens. **ARGENTINA. Corrientes:** Santo Tomé, ruta 41, 5–6 km al N de Galarza (ca. 28°4'S, 56°39"W), 17 Nov 1994 (fl), *Arbo et al 6402* (CTES); Estancia Ana Cuá, 17 Dec 1970 (fl), *Carnevali 2243* (CTES); Estancia Garruchos, cachuera, Ayo. Chimiray, 6 Feb 1972 (fr), *Krapovickas et al 21174* (CTES); General Paz, Arroyo Sta. Isabel at ruta 12 E of Itá Ibaté (ca. 57°30'W, 27°20'S), 9 Dec 1987 (fr), *Landrum 5701* (ASU, CTES); Estancia El Recreo, 21 km E Bonpland, costa río Uruguay, Dep. Paso de los Libres, 18 Nov 1973 (fl), *Lourteig et al 2737* (CTES); Monte Caseros, Dep. Monte Caseros, 19 Feb 1975 (fr), *Prause 0* (CTES); Empedrado, Estación Experimental INTA, 7 Dec 1978 (fl), *Schinini 16188* (CTES); 10 km S de Bella Vista, 8 Nov 1978 (fl), *Schinini & Ahumada 15894* (CTES, MO); 11 km S de Mercedes, antiguo camino a Curuzu Cuatia, Co. Pajarito, 23 Feb 1984 (fr), *Tressens et al 2420* (CTES). **Entre Ríos:** Concordia, Dec 1946 (fl), *Meyer 11007* (LIL). **Misiones:** Posadas, Lareto, Casa de Drewes, 26 Jan 1908 (fr), *Ekman 2056* (MICH, NY); San José, Feb 1961 (st), *Martinez Crovetto 8D-1* (CTES). **Tucumán:** Burruyacú, Cerro del Campo, 1000 m, Nov 1978 (fl), *Venturi 7582* (F).

BOLIVIA. Santa Cruz: Prov. Florida, 4 km N of center of Samaipata (18°08'S, 63°52'W), 2000–2100 m, 31 Dec 1992 (fr), *Nee & Vargas 43465* (ASU).

BRAZIL. Rio Grande do Sul: Continuacão da estrada Alegrete-Cerro do Tigre, apos o Cerro do Tigre, direcão rio Ibicuí, 11 Feb 1990 (fr), *Falkenberg & Sobral 15235* (MBM); Pôrto Alegre, Montserrat, 13 Nov 1941 (fl), *Emrich 8380* (LIL); Fazenda Faxinal, Arroio dos Ratos, 5 Nov 1980 (fl), *Hagelund 13420* (CTES, NY); Morro das Abertas, 9 Jan 1949 (fl), *Rambo 39674* (LIL); São Vicente do Sul, estrada a Cacequi, rio Ibicui, Dec 1985 (st), *Sobral & Marchiori 4544* (UB).

PARAGUAY. Central: Itá, Granja Isapy, orilla arroyo Lazarillo, 30 Jan 1966 (fr), *Krapovickas et al 12231* (CTES). **Cordillera:** Ypacaray, 6 Dec 1950 (fr), *Sparre & Vervoost 814* (LIL). **Misiones:** San Juan Bautista, ca. 8.5 km along road to Pilar, ca. 170 m, 8 Nov 1995 (fr), *Landrum 8790* (ASU); Ea. La Soledad, 3 km S de Santiago (56°46'W, 27°10'S), 3–4 Feb 1988 (fr), *Schinini & Vanni 26108* (ASU, CTES). **Paraguari:** Rt. 1, between Quindy and Caapucú, near km 246 (26°S, 57°15'W), ca. 250 m, 7 Nov 1995 (st), *Landrum 8764* (ASU).

URUGUAY. Cerro Largo: Arroyo Zapallar, 22 Dec 1961 (fr), *Praderi 740* (LIL). **Durazno:** Est. Las Palmas, Mar 1922 (st), *Osten 16563* (NY). **Montevideo:** La Colorada, 17 Nov 1947 (fl), *Legrand 2711* (NY).

Paysandú: Chapicuy, orillas del río Uruguay, Sta. Sofia, 15 Nov 1942 (fl), *Rosengurtt B-3250* (MO, NY). **Rivera:** Tranqueras, (fl), *Legrand 4145* (MICH, NY). **San José:** Rincón Gallinas, Dec 1931 (fl), *Herter 8051* (MO). **Tacuarembó:** Cerro Dos Hermanos, Mar 1922 (fr), *Osten 16651* (NY).

This entity has long gone by the name *Psidium incanum* (O. Berg) Burret, which is the correct name if one recognizes it at the specific level. It most closely resembles var. *mucronatum* and intergrades with it.

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BOOK NOTICES

Systematics/Monographs/Floras/Guides

GEYATA AJILVSGI. 2002. **Wildflowers of Texas. Revised Edition.** (ISBN 0-940672-73-1, pbk, laminated). Shearer Publishing, 406 Post Oak Road, Fredericksburg, TX 78624, U.S.A. (Orders: 800-458-3808, www.shearerpub.com). $19.95, 524 pp., numerous color photographs, 4 1/2 × 7 1/2".

From the inside cover flap.—"IN this revised edition of her popular *Wildflowers of Texas*, native-plant expert Geyata Ajilvsgi gives lay readers the most comprehensive field guide currently available on the state's abundant wildflowers. With the addition of 105 species, the book now contains, information on 482 of the most common wildflower species found in the state's major vegetation zones—from the mountains in the west to the swamplands in the east, from desert to piney woods to coastal plain, from the Panhandle to the semitropical Rio Grande Valley. Each entry reflects the most current scientific knowledge about the plant, such as recent changes in taxonomic classification."

The layout is nice with color photographs on the left side of the page and text on the right. Every plant listed includes a common name, family, bloom period, description, habitat, and a general note about the plant. It is fun to just read the various comments about individual species. The field guide includes a glossary, an illustrated glossary (floral structures, vegetative structures), selected bibliography that includes many up-to-date references, and an index of Latin names and a wealth of common names.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

ROBERT H. MOHLENBROCK. 2002. **The Illustrated Flora of Illinois. Grasses: *Bromus* to *Paspalum*. Second Edition.** (ISBN 0-8093-2359-1, hbk.) Southern Illinois University Press. P.O. Box 3697, Carbondale, IL 62902-3697, U.S.A. (Orders: 618-459-6633, 618-453-1221 fax, www.siu.edu/~siupress). $60.00, 416 pp, 284 line drawings, 6" × 9".

ROBERT H. MOHLENBROCK. 2002. **Vascular Flora of Illinois.** (ISBN 0-8093-2421-0, pbk.) Southern Illinois University Press. P.O. Box 3697, Carbondale, IL 62902-3697, U.S.A. (Orders: 618-459-6633, 618-453-1221 fax, www.siu.edu/~siupress). $50.00, 736 pp, 1 map (county map of Illinois), 6" × 9".

The Illustrated Flora of Illinois. Grasses: Bromus to Paspalum. Second Edition The second edition features 22 newly discovered taxa since the first edition in 1972. "For each new species, a full-page illustration is provided. This second edition updates the status of Illinois grasses. The book features 263 figures from the first edition plus 21 new figures for this edition by Paul W. Nelson." The drawings are excellent. Keys and distribution maps are included.

Vascular Flora of Illinois is the sequel to the first edition published in 1975 and to the second and enlarged edition in 1986. The latest edition covers over 3200 taxa, an increase of almost 300 since 1986. Besides keys to genera and species, common names, flowering times, habitats, and geographical distribution, the taxa below the rank of species are recognized and may be identified by keys.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

REVISION AND TYPIFICATION OF SOME SPECIES OF *IXORA* (RUBIACEAE) FROM CENTRAL AND SOUTHERN BRAZIL

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ABSTRACT

In connection with the treatment of *Ixora* for the *Flora Fanerogâmica do Estado de São Paulo*, *Flora Ilustrada Catarinense* and *Flora de Goiás e Tocantins*, it was necessary to undertake a taxonomic study of the taxa occurring in Central and Southern Brazil. Five native species occur in the state of São Paulo, and 12 taxa originally described by Müller Argoviensis are here treated as synonymous with the recognized species. Only one native species occurs in the state of Santa Catarina. Full typification, synonymies, brief descriptions, specimens cited, and a key to the *Ixora* of São Paulo are here presented.

KEY WORDS: *Ixora*, Ixoroideae, Rubiaceae, typification, Brazil.

RESUMEN

En conexión con el tratado de *Ixora* por la *Flora Fanerogâmica do Estado de São Paulo*, la *Flora Ilustrada Catarinense* y la *Flora de Goiás e Tocantins* fue necesario realizar un estudio taxonómico de los taxa presentes en Brasil central y meridional. Cinco especies nativas ocurren en el estado de São Paulo y doce taxa originariamente descritos por Müller Argoviensis son tratados aquí como sinónimos de especies reconocidas. Solamente una especie nativa ocurre en el estado de Santa Catarina. Se presentan aquí tipificaciones y sinonimias completas, descripciones, especímenes citados y una clave para las especies de *Ixora* de São Paulo.

Ixora is a pantropical genus of about 350 species, with most of them present in tropical Asia and the islands of the South Pacific, about 37 species in continental Africa, about 35 species in Madagascar, and about 45 species in the Neotropics. Although the African species have been recently studied by De Block (1998), revisions for the Neotropical or the Asiatic species have never been attempted.

During the preparation of the treatment of *Ixora* for the *Flora Fanerogâmica do Estado de São Paulo* (Delprete, in press) and *Flora Ilustrada Catarinense* (Delprete et al., submitted), and *Flora de Goiás e Tocantins*, it was necessary to examine material from many Brazilian and international herbaria, and to study the type specimens of the species described by Bentham (1850) and Müller Argoviensis (1875, 1881).

Johannes Müller (1828–1896) was renamed by C.F.P. von Martius (coordi-

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nator of *Flora Brasiliensis*) as Müller Argoviensis (because he was native of a small town in the canton of Aargau, Switzerland), to distinguish him from other contemporary botanists with the same last name. The personal herbarium of Müller Argoviensis was subsequently included in the Candolle Herbarium (G-DC). Because of their historical value, the specimens of this herbarium are not sent out on loan. In order to examine the type specimens of the *Ixora* species described by Müller Argoviensis, a set of about 80 black and white negatives were made by the staff of the G-DC Herbarium and sent to NY. The negatives were used to make large photographs, which were mounted on NY herbarium sheets. The present work would have not been possible without the close examinations of these photographs.

The most complete treatment of Brazilian species of *Ixora* still remains that of Müller Argoviensis (1881), where he expanded the original descriptions of his new species published a few years before (Müller Argoviensis 1875), and cited additional specimens of contemporary collectors. In his treatments, he distinguished the species of *Ixora* based on leaf shape, presence of colleters inside the calyx, and presence and shape of leaf-like bracts subtending the secondary branches of the inflorescences. All these characters are here considered of little taxonomic significance, and most of Müller Argoviensis' new taxa here studied are reduced to synonymy. In addition, the fruits of the species examined are quite uniform, in being spherical to subspherical and 5–7 mm in diameter, usually reddish to deep red, and consequently without any useful taxonomic characters. Most of the characters considered of taxonomic significance in the definition of the species presented below were found in the stipule shape, length of the stipular arista, leaf venation, inflorescence size and architecture, number of inflorescence secondary branches, flower bud shape (ovoid or oblong-ellipsoid at apex), corolla tube length, corolla lobes length and shape, and corolla tube/lobe ratio. A key to the species of the State of São Paulo is presented below.

Full typification and citation of specimens examined is here presented because this information can not be included in the concise format of the *Flora Fanerogâmica do Estado de São Paulo*. It is my hope that this work will provide an initial contribution towards the clarification of *Ixora* from central and southern Brazil; however, considerable work remains to be done before a revision of the Brazilian species of this difficult genus can be completed.

Ixora brevifolia Benth., Linnaea 23:448. 1850. TYPE: BRAZIL. MINAS GERAIS: without locality, 1845–1846 (fl), *Widgren 1119* (LECTOTYPE: UPS! V-134607, here selected; ISOLECTOTYPE: UPS n.v. V-102640; not at GOET, K, S).

Ixora thyrsoidea Muell. Arg., **syn. nov.**, Flora 58:455, 459. 1875. TYPE: BRAZIL. BAHIA: without locality, 1857, *Blanchet s.n.* (HOLOTYPE: G-DC n.v., photos at NY!).

Ixora warmingii Muell. Arg., **syn. nov.**, Flora 58:455, 459. 1875. TYPE: BRAZIL. MINAS GERAIS: Lagoa Santa, s.d. [1863–1865], *Warming s.n.* (LECTOTYPE: G-DC n.v., here selected, photos at C!, NY!).

Ixora glaziovii Muell. Arg., **syn. nov.**, in Mart , Fl. Bras. 6(5):460. 1881. TYPE: BRAZIL. RIO DE JANEIRO: Without locality, s.d. [1861–1895], *Glaziou 10932* (HOLOTYPE: G-DC n.v., photos at NY!; ISOTYPE: B†, photo at NY!).

Ixora membranacea Muell. Arg., **syn. nov.**, in Mart., Fl. Bras. 6(5):458. 1881. TYPE: BRAZIL. RIO DE JANEIRO: without locality, s.d. [1861–1895], *Glaziou 10947* (HOLOTYPE: G-DC n.v., photos at NY!; ISOTYPE: B†, photo at NY!).

Tree up to 20 m tall, to 35 cm at dbh; bark smooth; branchlets glabrous. **Stipules** 4–8 × 3–4 mm, base deltoid, arista 4–6 mm long, glabrous outside, densely sericeous-pubescent and intermixed with colleters inside. **Leaf** blades narrowly elliptic, oblong elliptic to obovate, (4–)8–20 × 1.5–6(–8) cm, apex acute or acuminate, base acute to round, subcoriaceous to coriaceous, glabrous; secondary veins 15–40 each side, tertiary venation subparallel-reticulate; petioles 4–10 mm long, glabrous. **Inflorescences** sessile or pedunculate, paniculate, multiflorous, 5–12 × 3–8 cm, with 2 or 3 lateral branches, these sparsely branches or corymbose; peduncles 2.5–4 cm long, or absent; **bracts** subtending the secondary branches narrowly triangular, 1–4 mm long; **bracteoles** triangular, 0.4–0.7 mm long. **Flower buds** oblong-ellipsoid at apex. **Pedicels** absent or to 2 mm long. **Flowers** sessile or short-pedicellate, fragrant. **Calyx** 0.7–1 mm long; lobes triangular or ovate, glabrous. **Corolla** 6–9 mm long, cream-white; tube 2.6–3.7 × 1–1.5 mm, glabrous outside, pubescent inside; lobes oblong, 3–5 × 0.8–2 mm, apex round, glabrous. **Stamens** 3.5–4.5 mm long; anthers narrowly oblong, ca. 2.5 mm long, apex acute. **Style** ca. 4–6 mm long; style branches narrowly oblong, ca. 2 mm long. **Fruit** globose, 5–6.5 mm diam., glabrous, red.

Selected specimens examined. **BRAZIL. Bahia:** Rd to Abaira, ca. 8 km N of town of Rio da Contas, ca. 13°33', 41°47'W, 1000 m, 18 Jan 1972 (fl), *Harley et al. 15251* (NY); Serra da Água de Rega, ca. 24 km N of Seabra, rd to Água de Rega, 1000 m, 25 Feb 1971 (fr), *Irwin et al. 31058* (NY); Serra da Água de Rega, ca. 28 km N of Seabra, rd to Água de Rega, 1000 m, 27 Feb 1971 (fr), *Irwin et al. 31184* (NY); rd. BA, 12 km from Mucugê, L entrance of Fda. Paraguaçu, 16 Dec 1984 (fl), *Lewis et al. s.n. (SPF 36789)* (NY). **Distrito Federal:** Bacia do Rio São Bartolomeu, 18 Dec 1979 (fl), *Heringer et al. 2950* (NY), 14 Jan 1981 (fr), *5985* (NY); Córrego da Papuda, near barra of Rio São Bartolomeu, 22 Jan 1981 (fr), *Heringer et al. 6026* (NY); Granja do Tamanduá, 6 Oct 1965 (fl), *Heringer et al. 10613* (NY); Rio Corumbá, 120 km from Brasília, 18 Jan 1968 (fl), *Heringer 11618* (NY). **Minas Gerais:** Serra do Cantagalo, São Tomé das Letras, 3 Nov 1984 (fr), *Mello Silva et al. s.n. (SPF 35862)* (NY). **Goiás:** Formosa, 20 Oct 1961 (fl), *Heringer 10740* (NY); Serra dos Pireneus, ca. 9 km S of Corumbá de Goiás, 1000 m, 1 Dec 1965 (fl), *Irwin et al. 10889* (NY); Serra do Caiapó, ca. 50 km S of Caiapônia, rd to Jataí, 900 m, 27 Jun 1966 (fr), *Irwin et al. 17885* (NY); Serra do Caiapó, 66 km of Jataí, 22 Oct 1964 (fl), *Prance & Silva 59565* (NY); Mun. Goiânia, rd. GOM-9, 2 km from Escola de Agron. e Veterinária, 23 May 1968 (fr), *Rizzo & Barbosa 1050* (UFG); Mun. Goiânia, rd. Goiânia-Leopoldo de Bulhões, 18 km from Goiânia, 2 Jul 1968 (fl), *Rizzo & Barbosa 1570* (UFG); Mun. Goiânia, rd GOM-6, 16 km from Goiânia, 2 Nov 1968 (fl), *Rizzo & Barbosa 2622* (UFG[2]); Mun. Goiânia, Morro dos Lobos, 3 Dec 1968 (fl), *Rizzo & Barbosa 2911* (UFG); Mun. Goiânia, rd Goiânia-Senador Canêdo (GOM-7), km 12, 5 Dec 1968 (fl), *Rizzo & Barbosa 2989* (UFG[2]), 27 Dec 1968 (fl), *3159* (UFG); Mun. Goiânia, rd. Goiânia-Senador Canêdo (GOM-7), km 12, 4 Mar 1969 (fl), *Rizzo & Barbosa 3905* (UFG); Mun. Jataí, towards Perolândia, 20 km from Rio Claro, 9 Nov 1972 (fl), *Rizzo 8607* (UFG); Rio Paranaíba, 20 km from Itumbiara, 23 Nov 1972 (fl), *Rizzo & Barbosa 8611* (UFG), 21 Dec 1972 (fl), *8697* (UFG); Mun. Goiânia, Universidade Federal de Goiás, Campus II, Bosque Auguste de Saint-Hilaire, 17 Nov 1978 (fl), *Rizzo et al. 10045* (UFG), 18 Nov 1997 (fl), *12258* (UFG). **São Paulo:**

Mun. Tatuí, rd Sorocabana, 1 Feb 1946 (fl), *Amaral 36* (SPSF); Mun. Moji Mirim, 27 Oct 1993 (fl), *Árbocz 14* (IAC), 14 Nov 1993 (fl), *61* (IAC); Mun. Santo Antonio de Posse, Fda. Palmital, 3 Dec 1993 (fl), *Árbocz 88* (IAC); Mun. Anhembi, Fda. Barreiro Rico, 15 Dec 1981 (fl), *César s.n.* (*HRCB 3048*), 30 Sep 1982 (fr), *s.n.* (*HRCB 3333*) (HRCB); Mun. Agudos, Fda. Cia. Cervejaria Brahma, 23 Oct 1997 (fl), *Cristianini & Assis Camargo 651* (SP), 20 Nov 1997 (fl), *718* (SP); Mun. São Paulo, Parque Estadual da Serra do Mar, Núcleo Curucutu, 23°59'S, 46°44'W, 19 Dec 1996 (fl), *Garcia et al. 967* (NY); Mun. Moji Guaçu, Fda. Campininha, 17 Jan 1977 (fl), *Gibbs & Leitão Filho 4275* (NY, UEC); Mun. Itararé, Ibiti, Estação Experimental Monte Alegre, 1 Aug 1946 (st), *Kuhlmann s.n* (*IAC 28616*) (IAC, SP); Mun. Ilha do Cardoso, 11–14 Dec 1979 (fr), *Leitão Filho et al. s.n.* (*UEC 10823*) (UEC); Mun. Pereira Barreto, Fda. Lagoinha II, 7 Nov 1985 (fl), *Martins et al. 95* (HRCB, SP, UEC); Mun. Campinas, Bosque dos Jequitibás, s.d. (fl), *Matthes 7757* (UEC), *7758* (UEC); Mun. Cajuru, Fda. Sta. Carlota, 15 Dec 1999 (fl), *Nicolau et al. 2091* (NY), *2092* (SP); Mun. Américo Brasiliense, 23 Sep 1992 (st), *Rocha 17* (ESA); Mun. Moji Guaçu, Reserva Biológica e Estação Esperimental, 21 Jun 1988 (st), *Rossi et al. 1195* (SP); Mun. Porto Ferreira, Reserva Florestal, 22 Nov 1975 (fl), *Silva et al. s.n.* (*UEC 13842*) (UEC); Mun. Águas de Lindóia, rd. to Barão de Ataliba, 9 May 1995 (fr), *Tamashiro et al. 1039* (SP, UEC).

A species occurring in the states of Minas Gerais, Goiás, Distrito Federal, Mato Grosso, Bahia, Rio de Janeiro, Espirito Santo and São Paulo, usually found in the moist forests of the coastal states, and in the gallery forests of the cerrado biome of central Brazil. Many specimens have been traditionally annotated as *Ixora warmingii*, which is a later synonym of this species.

Because *Ixora brevifolia* Benth. was originally described by Bentham (1850), the type material was expected to be housed at K. After two distinct searches by the K herbarium staff, no type material (*Pohl s.n.* and *Widgren 1119*) pertaining to this species was found at this institution. Therefore, a search of duplicate specimens of *Widgren 1119* was initiated in the main herbaria where Widgren's collections were distributed (C, GOET, S, UPS; Vegter, 1988). Two duplicates of *Widgren 1119* were found at UPS, one of which is here selected as the lectotype of *Ixora brevifolia*.

Ixora gardneriana Benth., Linnaea 23:448. 1850. TYPE: BRAZIL. RIO DE JANEIRO: woods of Tijuca, Dec 1840, *Gardner 5496* (HOLOTYPE: K!, photo at NY!; ISOTYPE: K!).

Ixora schottiana Muell. Arg., **syn. nov.**, Flora 58:455, 459. 1875. TYPE: BRAZIL. RIO DE JANEIRO: Serra Tingua, s.d. [1817–1820], *Schott 889* (LECTOTYPE: G-DC n.v., here selected, photos at NY!; ISOTYPE: K!, photo at NY!).

Ixora riedeliana Muell. Arg., **syn. nov.**, Flora 58:455, 459. 1875. TYPE: BRAZIL [Southern Brazil]: without locality, s.d. [1821–1836], *Riedel s.n.* ["478"] (HOLOTYPE: G-DC n.v., photos at NY!; dubious ISOTYPE: NY!).

Ixora obscura Muell. Arg., **syn. nov.**, Flora 58:455, 459. 1875. TYPE: BRAZIL [Southern Brazil]: without locality, s.d. [1815–1817], *Sello s.n.* (HOLOTYPE: G-DC n.v., photos at NY!; ISOTYPE: B† [*Sello 6018*], photo at NY!).

Ixora truncata Muell. Arg., **syn. nov.**, in Mart., Fl. Bras. 6(5):459. 1881. TYPE: BRAZIL. RIO DE JANEIRO: Rio de Janeiro, s.d. [1861–1895], *Glaziou 10933* (LECTOTYPE: G-DC n.v., here selected, photos at NY!; ISOLECTOTYPE: B†, photo at NY!).

Tree; bark smooth; branchlets glabrous. **Stipules** 2.5–3.5 × 1.5–2 mm, base deltoid, arista 1.5–2 mm long, glabrous outside, densely sericeous-pubescent and intermixed with colleters inside. **Leaf** blades elliptic or ovate, 5–13 × 2.5–5.5 cm,

apex acute, base acute, subcoriaceous, glabrous; secondary veins 6–14 each side, tertiary venation reticulate; petioles 5–12 mm long, glabrous. **Inflorescences** pedunculate, paniculate, pauci- or multi-florous, 5–11 × 3.5–6 cm; peduncles 0.5–2.5 cm long; **bracts** subtending the secondary branches often foliose, narrowly triangular to obovate, 5–10 mm long; **bracteoles** 1 or 2 per flower, triangular, 2–3 mm long, or absent. **Flower buds** ovoid at apex. **Pedicels** 2–7 mm long. **Flowers** pedicellate (rarely sessile), fragrant. **Calyx** 0.8–1 mm long; lobes deltoid, glabrous. **Corolla** 8–9 mm long, cream-white; tube 4.5–5.5 × 1–1.2 mm, glabrous outside, pubescent inside; lobes ovate, 3.5–4 × 2–2.5 mm, apex round, glabrous. **Stamens** 3.5–4 mm long; anthers narrowly oblong, 3.2–3.7 mm long, apex apiculate. **Style** 10.5–11 mm long; style branches narrowly oblong, 1.7–2 mm long. **Fruit** unknown.

Illustration.—Mart., Fl. Bras. 6(5), Tab. 9. 1881 (as *Ixora schottiana*).

Additional specimens examined. **BRAZIL. São Paulo:** São Paulo, Fda. Itatuba, 23 Dec 1931 (fl), *Amaral s.n. (SP 28628)* (NY, SP); São Paulo, Jardim Botânico, tree n. 179, 9 Dec 1931 (fl), *Hoehne s.n. (SP 28588)* (NY[2], SP); Mun. Campinas, Bosque de São José, 13 Sep 1994 (fl), *Santin & Bertani s.n. (UEC 33566)* (NY, UEC).

A very rare species, and certainly in danger of extinction, that occurs in the Atlantic forests of the states of Rio de Janeiro (Serra do Tinguá e Serra da Estrella) and São Paulo (Fda. Itatuba and Bosque de São José).

The holotype specimen has the stamp "Herbarium Benthamianum" and a label with the handwriting "5496, *Ixora Gardneriana* Benth, Linnaea 13:448" and the print "Brasilia, Gardner, 1841." Whereas the isotype specimen has the stamp "Herbarium Hookerianum" and the handwritten label "5496, *Faramea* sp., a large shrub - woods of Tijuca, Dec./[18]40." Because the label of the isotype was handwritten by Gardner, the locality and date reported on this specimen are considered more accurate.

Ixora heterodoxa Muell. Arg., Flora 58:454, 459. 1875. TYPE: BRAZIL. RIO DE JANEIRO: near Rio de Janeiro, s.d. [1861–1895], *Glaziou 6154* (HOLOTYPE: G-DC n.v., photos at NY!; ISOTYPE: B†, photo at NY).

Ixora burchelliana Muell. Arg., **syn. nov.**, Flora 58:454, 458. 1875. TYPE: BRAZIL. SÃO PAULO: "Prov. São Paulo," s.d. [1825–1830], *Burchell 3208* (HOLOTYPE: fragments G-DC n.v., photos at NY!; ISOTYPE: BR!).

Ixora dimorphophylla Muell. Arg., **syn. nov.**, Flora 58:454, 458. 1875. TYPE: BRAZIL. Rio de Janeiro: Without locality, *Glaziou 705* (HOLOTYPE: C!, photo at NY!; ISOTYPES: BR!, K!; photo-K at NY!).

Ixora heterophylla Muell. Arg., **syn. nov.**, in Mart., Fl. Bras. 6(5):68. 1881. TYPE: BRAZIL. RIO DE JANEIRO: Serra Estrella, in fruticetis umbrosis, s.d. [1821–1836], *Riedel 342* (HOLOTYPE: G-DC n.v., photos at NY!; ISOTYPE: BR!).

Shrub 2–3(–5) m tall, rarely trees 5–8 m tall, 10–15 cm at dbh; bark smooth; branchlets glabrous. **Stipules** 5–6 × 2.5–3.5 mm, base deltoid, arista 2–3.5 mm long, glabrous outside, densely sericeous-pubescent and intermixed with colleters inside. **Leaf** blades ovate, elliptic to obovate, 5–18 × 2.5–7 cm, apex acute

or acuminate, base acute, membranaceous to chartaceous, glabrous; secondary veins 6–16 each side, tertiary venation reticulate; petioles 5–20 mm long, glabrous. **Inflorescences** pedunculate, paniculate, multiflorous, 6–9 × 4.5–9 cm, rachis usually filiform, red; peduncles 1.5–4 cm long, glabrous; leaves subtending the inflorescence smaller than those of lower nodes; **bracts** subtending the secondary branches narrowly triangular to lanceolate, 4–7 × 1–2 mm long; **bracteoles** 1 or 2 (rarely 3) each flower, triangular, 2–3 mm long, or rarely absent. **Flower buds** ovoid at apex. **Pedicels** absent or 2–4 mm long. **Flowers** sessile or short-pedicellate, fragrant. **Calyx** 0.7–1 mm long; lobes triangular, glabrous. **Corolla** 9–12 mm long, cream-white; tube 6–8.5 × 0.7–0.9 mm, glabrous outside, sparsely pubescent inside; lobes oblong, 2–3.5 × 1.7–2.5(–3.5) mm, apex round (rarely microscopically apiculate), glabrous. **Stamens** 1.6–1.9 mm long; anthers narrowly oblong, 1.5–1.8 mm long, apex apiculate. **Style** 8.5–13 mm long; style branches ovate, ca. 1 mm long. **Fruit** subglobose, didymous, 5–7 × 4–6 mm, glabrous, red to blackish.

Selected specimens examined: **BRAZIL. Paraná:** Mun. Guaraqueçaba, Rio Murato, 11 Dec 1970 (fl), *G. Hatschbach 25807* (UB). **Rio de Janeiro:** Taquara da Tijuca, 1 Nov 1972 (fl), *D. Sucre 9722* (NY, UB). **São Paulo:** Mun. Iguape, Estação Ecologica Juréia-Itatins, 7 Mar 1993 (fr), *Anunciação et al. 190* (NY), 29 Oct 1994 (fl), *Anunciação & Rossi 392* (NY); Mun. Ubatuba, Picinguaba, 11 Jan 1993 (fl), *Assis 65* (NY); Mun. Ubatuba, 19 Apr 1995 (fr), *Assis & Carneiro 529* (NY); Mun. Cananéia, Ilha do Cardoso, 10 Feb 1981 (fl), *Baitello 46* (SPSF 7879), 25 Oct 1989 (fl), *Cordeiro et al. 569* (IAC); between Ubatuba and Caraguatatuba, 10 m, 22 Aug 1976 (fl), *Davis et al. 59883* (UEC); Mun. Ubatuba, 11 Mar 1989 (fr), *Furlan et al. 677* (HRCB, SPSF), 12 Mar 1989 (fr), *780* (SPSF, NY), *788* (NY), 8 Dec 1989 (fl), *1014* (NY); Mun. Sete Barras, Fda. Intervales, 12 Mar 1994 (fr), *Galetti et al. 119* (SP); Mun. Cananéia, Ilha do Cardoso, 11 Feb 1981 (fl), *Jung-Mendaçolli 479* (IAC), 31 Oct 1985 (fl), *Kirizawa 1529* (IAC); São Paulo, Jardim Botânico, 4 Dec 1951 (fl), *Kuhlmann 2806* (SP, UEC); Mun. Cubatão, Vale do Rio Pilões, 4 Oct 1988 (fl), *Leitão Filho & Pagano s.n. (UEC 20804)* (UEC); Mun. Cubatão, 23 Sep 1896 (fl), *Loefgren s.n. (SP 11557)* (SP); Mun Peruíbe, Estação Ecológica de Juréia, 11 Nov 1982 (fl), *Rodrigues & Figueiredo s.n. (UEC 15667)* (UEC), 17 Nov 1982 (fl), *s.n. (UEC 15679)* (NY, UB, UEC); Mun. Peruíbe, Juréia, 6 Nov 1990 (fl), *Simão-Bianchini 252* (NY); Mun. Peruíbe, Estação Ecologica Juréia Itatins, Oct 1991 (fl), *Sobral & Attili 7320* (HRCB); Mun. Peruíbe, Foz do Rio Guaraú, 9 Oct 1995 (fl), *Souza et al. 9267* (NY).

A common species occurring in the states of Rio de Janeiro, São Paulo and Paraná, distinguishable by its leaf blades membranaceous to chartaceous, with tertiary (subsecondary) veins parallel to the secondary veins, inflorescences pauciflorous and with delicate-thin rachis (often filiform), and flower buds narrowly-tubular at base and ovoid at apex.

The names *Ixora heterodoxa*, *I. dimorphophylla* and *I. burchelliana* are synonymous and have equal priority because they were published in the same article by Müller Argoviensis (1875). The name *I. heterodoxa* is chosen over the others because its holotype is a complete specimen with flowers in bud and in anthesis, while the holotype of *I. burchelliana* (G-DC) is only represented by a leaf fragment. No type specimens of *I. dimorphophylla* are present at G-DC, and its holotype is at C, as it was indicated by Müller Argoviensis (1875).

Ixora syringiflora (Schltdl.) Muell. Arg., Flora 58:455. 1875. *Psychotria syringaeflora* Schltdl., Linnaea 28: 516. 1856. TYPE: BRAZIL [Bahia?]: locality unknown, s.d. [1828–1856], *Blanchet 3348* (HOLOTYPE: B†, photo at NY!).

Ixora benthamiana Muell. Arg., **syn. nov.**, Flora 58:455, 459. 1875. TYPE: BRAZIL. RIO DE JANEIRO: Rio São João, s.d. [1817–1820], *Pohl 2209* (LECTOTYPE, G-DC n.v., here selected, photo at NY!).

Tree to 10 m tall; branchlets glabrous. **Stipules** 4–6 × 2.5–3.5 mm, base deltoid, arista 3–4 mm long, glabrous outside, densely sericeous-pubescent and intermixed with colleters inside. **Leaf** blades elliptic, oblong-ovate, to narrowly obovate, 5.5–21 × 3–6.5 cm, apex acute, commonly deltoid-acuminate, base acute, membranaceous to chartaceous, glabrous; secondary veins 16–34 each side, tertiary venation reticulate; petioles 5–20 mm long, glabrous. **Inflorescences** pedunculate, paniculate, multiflorous, 10–14 × 10–14 cm, with 4–5 lateral branches laxely paniculate; peduncles 1.5–4 cm long, glabrous; leaves subtending the inflorescence smaller than those of lower nodes; **bracts** subtending the secondary branches narrowly triangular to narrowly elliptic, 6–15 × 1–4 mm long; **bracteoles** 1 or 2 each flower, ovate to oblong, 0.7–1 mm long, or rarely absent. **Flower buds** oblong-ellipsoid at apex. **Pedicels** absent or 2–5 mm long. **Flowers** sessile or short-pedicellate, fragrant. **Calyx** 0.7–1 mm long; lobes triangular or ovate, glabrous. **Corolla** 6.5–7.5 mm long, cream-white; tube 2–2.9 × 0.8–1 mm, glabrous outside, sparsely pubescent at distal portion inside; lobes oblong, 3.8–4.6 × 1.5–1.8 mm, apex round, glabrous. **Stamens** ca. 4.5 mm long; anthers narrowly oblong, ca. 3 mm long, apex apiculate. **Style** 6.5–8.5 mm long; style branches narrowly oblong, 1.5–2 mm long. **Fruit** unknown.

Illustration.—Mart., Fl. Bras. 6(5), Tab. 10. 1881 (as *Ixora benthamiana*).

Additional specimens examined. **BRAZIL. São Paulo:** Mun. São Paulo, Fda. Itatuba, 23 Dec 1931 (fl), *Amaral s.n. (SP 28628)* (K, MO, NY, SP); Mun. Porto Ferreira, Reserva Estadual de Porto Ferreira, 2 Dec 1981 (fl), *Bertoni s.n. (UEC 16894)* (NY, UEC); Mun. Campinas, Reserva Municipal de Santa Genebra, 7 Nov 1988 (fl), *Leitão Filho & Morellato s.n. (UEC 22901)* (UEC).

This species easily recognized by its laxely paniculate, many-branched, multiflorous inflorescences. It is a very rare, or probably extinct, species known only from four historical collections from the states of Rio de Janeiro and São Paulo (and probably Bahia, *Blanchet 3348*, the type specimen).

Ixora venulosa Benth., Linnaea 23:446. 1850. TYPE: BRAZIL. MINAS GERAIS: Caldas, s.d. [1841–1874], *Regnell I.275b* (LECTOTYPE, K!, here selected, photo at NY!).

Shrub to 5 m tall or rarely **tree** to 9 m tall; bark rugose; branchlets glabrous. **Stipules** 4–8 × 3–4 mm, base narrowly triangular to oblong, arista 1–3 mm long, glabrous outside, densely sericeous-pubescent and intermixed with colleters inside. **Leaf** blades narrowly elliptic, oblong-elliptic, narrowly obovate to obovate, (1.5–)4–14 × 1–6 cm, apex acute, often acuminate, base acute or decurrent, chartaceous to subcoriaceous, glabrous; secondary veins fine and dense, 30–60 each side, tertiary venation subparallel to the secondary (sometimes somewhat

reticulate); petioles 2–15 mm long, glabrous. **Inflorescences** pedunculate, paniculate, pauciflorous, 2–8 × 1.5–6 cm, with 1 or 2 lateral branches, these sparsely branched; peduncles 1–6 cm long, glabrous; **bracts** subtending the secondary branches narrowly triangular, 7–10 × ca. 1 mm long, to narrowly elliptic, 10–13 × 3–5 mm; **bracteoles** 1 or 2 each flower, narrowly oblong-triangular, or absent. **Flower buds** ovoid at apex. **Pedicels** absent or to 2 mm long. **Flowers** sessile or short-pedicellate, fragrant. **Calyx** 0.3–1.2 mm long; lobes triangular or ovate, glabrous. **Corolla** 8.5–10.5 mm long, cream-white; tube 4.5–6.5 × 0.7–0.9 mm, glabrous outside, sparsely sericeous-pubescent inside; lobes oblong-ovate, 3.5–3.8 × 1.5–2.2 mm, apex round, glabrous, sometimes with undulate margin. **Stamens** 3.5–4 mm long; anthers narrowly oblong, 2.5–3 mm long, apex apiculate. **Style** 6.5–8.5 mm long; style branches oblong, 1.3–1.7 mm long. **Fruit** globose, 5–6.5 mm in diam., glabrous, red.

Selected specimens examined: **BRAZIL. Minas Gerais:** Monte Belo, Fda. Monte Alegre, 21 Feb 1982 (fr), *Vieira 300* (NY); Monte Belo, Fda Lagoa, Mato Olaria, tree n. 498, 2 Nov 1987 (fl), *Vieira 1334* (NY). **Paraná:** Mun. Antonina, Reserva Biológica de Sapitanduva, 25°25'S, 48°43'W, 28 Nov 1984 (fl), *Cervi et al. s.n. (UPCB 22718)* (NY); Mun. Paranaguá, Serra da Prata, 50 m, 2 Nov 1962 (fl), *Hatschbach 9458* (HBR, NY); Mun. Morretes, Prainhas, 50 m, 29 Nov 1966 (fl), *Hatschbach 15290* (HBR, NY); Mun. São José da Boa Vista, Rio Jaguariaiva, Corredeira Paulista, 19 Nov 1970 (fl), *Hatschbach 25569* (NY); Mun. Guaraqueçaba, trail to Paraquara, 28 Oct 1971 (fl), *Hatschbach 27697* (US); Mun. Cascavel, Autodromo de Cascavel, 25 Oct 1975, *Hatschbach 37352* (US); Mun. Cerro Azul, Rio Turvo, 5 Oct 1977 (fl), *Hatschbach 40215* (NY); Mun. Marumbi, Serra do Mar, Nov 1971, *Kuniyoshi 3121* (US); Mun. Cerro Azul, Mato Preto, Rio Ribeira, 10 Feb 2001 (fr), *Ribas & Silva 3214* (US); Mun. São José dos Pinhais, Castelhanos, Rio Arraial, 30 Oct 1996 (fl), *Silva & Saldanha 1742* (NY, US); Mun. Guaratuba, Rio Arraial, Fda. Bamerindus, 1 Nov 1996 (fl), *Silva & Saldanha 1772* (US). **Rio de Janeiro:** Rio de Janeiro, s.d., *Glaziou s.n.* (NY). **Santa Catarina:** Mun. Garuva, Três Barras, 21 Jan 1958 (fr), *Reitz & Klein 6223* (FLOR, HBR, NY, US); Mun. Joinville, s.d., *Schenk 1209* (K. Schum. in Mart., Fl. Bras. 6(6):399, 1889). **São Paulo:** Mun. Teodoro Sampaio, Parque Estadual do Morro do Diabo, 22 Jun 1994 (fr), *Baitello 681* (SP, SPSF); Mun. Corumbatai, rd. Washington Luiz, 22°15'S, 47°42'W, 27 Oct 1993 (fl), *Barreto et al. 1512* (ESA); Mun. Cabreúva, 23°16'S, 47°02'W, 16 Mar 1994 (fr), *Barreto et al. 2175* (ESA, NY); Mun. Campinas, Fda. São Vicente, 11 Oct 1989 (fl), *Bernacci s.n. (ESA 13210, UEC 25044)* (ESA, UEC), 29 Aug 1990 (fr), *117* (NY); Mun. Tietê, Instituto Agronômico, 20 Jul 1994 (fr), *Bernacci et al. 528* (NY, UEC); Dto. Souza, Condominio Colinas do Atibaia, 12 Sep 1995 (fl), *Cardamone et al. 186* (ESA, NY, UEC); Mun. Ipeúna, 11 Oct 1985 (fl), *Catharini & Mantovani 471* (ESA, NY); Mun. Anhembi, Fda. Barreiro Rico, 9 Oct 1979 (fl), *César s.n. (HRCB 2404)* (HRCB), 16 Oct 1981 (fl), *s.n.* (NY), 15 Dec 1981 (fr), *s.n. (HRCB 3049)* (HRCB, NY); Mun. Itirapina, 21 Dec 1983 (fl), *Cesár s.n. (HRCB 3770)* (HRCB, NY); Mun. Assis, Estação Ecologica, 9 Apr 1992 (fr), *Durigan s.n. (SPSF 15117)* (SPSF); Mun. Eldorado, Caverna do Diabo, 24°38'S, 48°23'S, 9 Feb 1995 (fr), *Fernandes et al. 32695* (ESA, NY, UEC); Mun. Botucatú, Fda. São João, 19 Oct 1988 (fl), *Gabriel s.n. (HRCB 10569)* (HRCB); Mun. Guarulhos, Aeroporto Internacional, 22 Nov 1984 (fl), *Gandolfi et al. s.n. (ESA 5605)* (ESA, NY); Mun. São Pedro, Cachoeira da Peroba, 22°32'S, 47°56'W, 22 Feb 1991 (fr), *Gandolfi et al. s.n. (ESA 32657)* (ESA, NY); Mun. São Paulo, Butantan, 1 Dec 1921 (fl), *Gehrt s.n. (SP 7538)* (NY, SP); Mun. Valinhos, área de reforma agrária, 16 Aug 1994 (fr), *Jung-Mendaçolli et al. 609* (NY); Mun. Jundiaí, Estação Esperimental do IAC, 28 Sep 1994 (fl), *Jung-Mendaçolli et al. 624* (IAC, NY, UEC), 5 Apr 1995 (fr), *1412* (NY, UEC); Mun. Ipanema, 20 Oct 1887 (fl), *Loefgren s.n.* (NY, SP); Mun. São Paulo, Instituto de Biociência, Cidade Universitaria, 740 m, 19 Aug 1972 (fr), *Klein 10210* (HBR, NY, US), 23 Nov 1973, *10980* (HBR, NY, US); Mun. Amparo, Monte Alegre, Fda. Sta. Isabel, 07 May 1942 (fl), *Kuhlmann & Lemos 1179* (NY, SP); Mun. Itararé, Ibiti, 900 m, 26 Jul 1946, *Kuhlmann &*

Kuhn 1386 (IAC, NY), 29 Jul 1946 (st), *Kuhlmann 1393* (SP); Mun. São João da Boa Vista, 12 Nov 1947 (fl), *Kuhlmann 1484* (IAC, NY); Mun. Jundiaí, Serra do Japi, 7 Nov 1981 (fl), *Leitão Filho et al. s.n. (UEC 13102)* (NY, UEC), *s.n. (UEC 13146)* (UEC); Mun. Santa Rita do Passo Quatro, Parque Estadual de Vassununga, 26 Oct 1978 (fl), *Martins s.n. (UEC 9999)* (UEC), *s.n. (UEC 10000)* (UEC); Mun. Paulínia, Fda. São Francisco, 20 Apr 1980 (fr), *Martins et al. s.n. (UEC 11170)* (UEC); Mun. Águas da Prata, Reserva Estadual, 47°20'W, 21°52'S, 1120 m, 21 Mar 1994 (fr), *Martins et al. 31413* (NY, SP); Mun. Atibaia, Fda. Grota Funda, 16 Nov 1987 (fl), *Meira Neto et al. s.n. (UEC 21316)* (UEC); Mun. Avaí, Rio Batalha, 9 Apr 1997 (fr), *Miranda & Miranda 322* (SP), 16 Oct 1997 (fl), *376* (NY); Mun. Guareí, Sarandi, 23°20'S, 48°14'W, 9 Nov 1980 (fl), *Neves & Cerantola IPH-USP 37* (UEC); Mun. Cajuru, Fda. Santana, 3 Oct 1999 (fl), *Nicolau et al. 1792* (SP); Mun. Jaú, Fda. Santo Antonio, 14 Oct 1988 (fl), *Nicolini s.n. (HRCB 11930)* (HRCB); Mun. Américo Brasiliense, Fda. Serrinha, 25 May 1944 (fr), *Pickel s.n. (SPSF 1108)* (SPSF); Mun. Campinas, Bairro Helvétia, sítio São Francisco, 4 Nov 1946 (fl), *Pickel s.n. (SPSF 2836)* (SPSF); Mun. Ipeúna, Remanescente Florestal do Rio Passa Cinco, 10 May 1989 (fr), *Rodrigues & Zandoval s.n. (ESA 6510)* (ESA, NY); Mun. Itu, 25 Dec 1897 (fl), *Russel 198* (SP); Mun. Campinas, Reserva Municipal de Santa Genebra, 3 Jul 1991 (st), *Zickel s.n. (UEC 30350)* (UEC); Moji Guaçu, Reserva Biológica, 2 Jun 1992 (fl), *Zifirino & Romaniuc Neto 16* (NY, SP).

PARAGUAY: Alto Paraná: Reserva Biológica, near Río Itabó, embalse Itaipú of Río Paraná, 25°05'S, 54°05'W, 16 Oct 1996 (fl), *Schinini et al. 31471* (NY).

A species readily distinguishable for the leaf blades with fine, dense venation (30–60 secondary veins each side), common in the moist Atlantic forests of the Brazilian states of Rio de Janeiro, São Paulo, Paraná, and Santa Catarina, and in the gallery forests of the cerrado biome of Minas Gerais, and occasionally found in Paraguay.

KEY TO THE NATIVE SPECIES OF *IXORA* OF THE STATE OF SÃO PAULO, BRAZIL

1. Leaf blade with dense, equal secondary venation (30–60 each side); tertiary veins dense and parallel to the secondary veins _____ **I. venulosa**
1. Leaf blade with sparse, unequal secondary venation (6–40 each side); tertiary veins subreticulate.
   2. Corolla lobes shorter than the tube; flower buds ovoid at apex.
      3. Corolla tube 6–8.5 mm long, lobes 2–3.5 mm long; stipules 5–6 × 2.5–3.5 mm, with an arista 2–3.5 mm long _____ **I. heterodoxa**
      3. Corolla tube 4.5–5.5 mm long, lobes 3.5–4 mm long; stipules 2.5–3.5 × 1.5 2 mm, with an arista 1.5 mm long _____ **I. gardneriana**
   2. Corolla lobes longer than the tube; flower buds oblong-ellipsoid at apex.
      4. Inflorescence 10–14 cm in diam., with 4–5 secondary branches, these densely branched and laxely paniculate _____ **I. syringiflora**
      4. Inflorescence 3–8(–10) cm in diam., with 2–3 secondary branches, these sparsely branched and corymbiform _____ **I. brevifolia**

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A NEW SECTION OF *BACCHARIS* (ASTERACEAE: ASTEREAE), AND NOTES ON ALLIED TAXA

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ABSTRACT

A new section of *Baccharis* is described: sect. *Punctatae*, including six species formerly placed in sect. *Aristidentes* (*B. bigelovii*, *B. crassicuneata*, *B. mexicana*, *B. sulcata*, *B. thesioides*, and *B. zamoranensis*). *Baccharis palmeri* is excluded from sect. *Aristidentes* while the South American *B. hirta* is added. Six species (*B. auriculigera*, *B. huairacajensis*, *B. klattii*, *B. maxima*, *B. volubilis*, and *B. zumbadorensis*) are added to sect. *Tubulatae*. A key is provided to differentiate these allied sections, as well as the related sect. *Bogotenses*.

RESUMEN

Se describe una nueva sección de *Baccharis*: sect. *Punctatae*, la cual incluye seis especies previamente ubicadas en la sección *Aristidentes* (*B. bigelovii*, *B. crassicuneata*, *B. mexicana*, *B. sulcata*, *B. thesioides* y *B. zamoranensis*). *Baccharis palmeri* es excluida de la sección *Aristidentes*, mientras que la especie sudamericana *B. hirta* es agregada a ella. Seis especies (*B. auriculigera*, *B. huairacajensis*, *B. klattii*, *B. maxima*, *B. volubilis* y *B. zumbadorensis*) son agregadas a la sección *Tubulatae*. Se provee una clave para diferenciar estas secciones afines, incluyendo asimismo la sección *Bogotenses*.

In a revision of the infrageneric taxonomy of North and Central American species of *Baccharis*, Nesom (1990) proposed the section *Aristidentes* to include 12 species. Later, the same author (Nesom 1998) recognized two informal groups within this section: the "*Baccharis multiflora* complex", including 6 species (*B. brevipappa* (McVaugh) G.L. Nesom, *B. mexicana* Cuatrec., *B. multiflora* Kunth – the type species of the section–, *B. serrifolia* DC., *B. sordescens* DC., and *B. zamoranensis* Rzed.), and the "*Baccharis thesioides* complex", comprising 3 species (*B. bigelovii* A. Gray, *B. sulcata* DC., and *B. thesioides* Kunth). With further observation, the differences between these two groups have proved to be more significant, especially when two closely related South American taxa, sect. *Bogotenses* Cuatrec. and sect. *Tubulatae* Cuatrec., are also considered. Effectively, the "*B. multiflora* group" shares more features with these South American taxa than with the "*B. thesioides* group" (see key below); therefore, this taxon is here given formal recognition at sectional rank, as follows.

Baccharis sect. **Punctatae** Giuliano & G.L. Nesom, sect. nov. TYPE: *Baccharis bigelovii* A. Gray.

Sectioni *Aristidenti* similis, sed plantis glutinosis nidis pilosis vestitis, foliis uni- vel obscure trinervatis et achaeniis minoribus differt.

Erect shrubs or subshrubs, glutinous, covered by minute tufts of (microscopic) biseriate glandular hairs; on both leaf surfaces, each tuft is placed in a depression of circular contour, altogether forming a characteristic dotted pattern. Leaves pseudopetiolate, uni- or trinervate, margins aristate-serrate (rarely entire). Capitula pedicellate, arranged in simple or compound corymbs, altogether forming a false panicle. Involucres campanulate. Receptacles flat or slightly convex, alveolate, epaleate. Ratio of carpellate: staminate florets ca. 1:1. Carpellate corollas filiform, apically truncate and crowned by long and short biseriate hairs. Achenes terete, 1.2–2.2 mm long, 5–8-ribbed, glabrous or with few uniseriate hairs with apiculate terminal cell; pappus bristles in 1–2 series, persistent, slightly accrescent. Staminate corollas campanulate, 5-lobed at apex; style branches lanceolate, free; pappus bristles apically broadened.

Includes 6 species, distributed from the southwestern United States to southern Mexico.

1. **B. bigelovii** A. Gray, Rep. U.S. Mex. Bound., Bot. 84. 1859.
2. **B. crassicuneata** G.L. Nesom, Phytologia 84:43. 1998.
3. **B. mexicana** Cuatrec., Brittonia 12:195. 1960.
4. **B. sulcata** DC., Prodr. 5:419. 1836.
5. **B. thesioides** Kunth, in Humboldt, Bonpland & Kunth, Nov. gen. sp. 4 [quarto]: 61. 1820.
6. **B. zamoranensis** Rzed., Brittonia 24:400. 1972.

Formerly, *B. mexicana* and *B. zamoranensis* were included in the "*B. multiflora* complex" of sect. *Aristidentes* (Nesom 1998) but now are classified within *Punctatae*, as they are glutinous plants dotted with tufted hairs.

Section *Punctatae* is closely related to sect. *Aristidentes*, sect. *Bogotenses* and sect. *Tubulatae*; the four taxa form a complex characterized by the capitulescence architecture (a false panicle of compound corymbs), achenes with 5–8 pale ribs, glabrous or with few uniseriated hairs, and pappus with persistent accrescent bristles in 2–3 series. These sections can be differentiated by the following features:

1. Plants glutinous, dotted by minute (microscopic) tufts of glandular hairs, without other vestiture. Leaves uni- or obscurely trinervate. Achenes 1.2–2.2 mm long. _____ Sect. **Punctatae**
1. Plants non-glutinous, non dotted by minute hair tufts but densely or loosely clothed by conspicuous (non-microscopic), non-glandular uniseriate hairs with acuminate terminal cell, often incurved. Leaves usually reticulate-nervate, trinervate in some species. Achenes 2.5–4 mm long.
   2. Scandent shrubs, densely pubescent, with long uniseriate conic hairs accompanying the uniseriate hairs with acuminate terminal cell. Capitula often grouped in few-headed inflorescences; carpellate involucres 7-9 mm long. Staminate florets with tubulose elongate limb and short straight lobes _____ Sect. **Tubulatae**
   2. Scandent or erect shrubs, without conic hairs but densely or loosely clothed by

uniseriate hairs with acuminate terminal cell. Capitula usually grouped in many-headed inflorescences; carpellate involucres 3 -6 mm long. Staminate florets with short limb and developed recurved lobes.

3. Scandent shrubs, subglabrous, with few isolated hairs. _____ Sect. **Bogotenses**
3. Erect shrubs, densely pubescent. _____ Sect. **Aristidentes**

The following couplet provides a summary of the contrasts between sect. *Punctatae* and the taxon from which it was segregated, sect. *Aristidentes*:

1. Plants glutinous, dotted by minute tufts of (microscopic) glandular hairs, without other vestiture. Leaves uni- or obscurely trinervate. Achenes 1.2–2.2 mm long. _____ Sect. **Punctatae**
1. Plants non-glutinous, non dotted by minute hair tufts but densely clothed by conspicuous (non-microscopic), non-glandular uniseriate hairs with acuminate terminal cell, often incurved. Leaves usually reticulate-nervate, trinervate in some species. Achenes usually 2.5–3 mm long. _____ Sect. **Aristidentes**

Further notes on sect. *Aristidentes*

Several of the species originally included in sect. *Aristidentes* are here relocated to the new section *Punctatae*. *Baccharis palmeri* Greenm. is also here excluded from sect. *Aristidentes* since it lacks the pubescence characteristic of this taxon, and it is placed in sect. *Angustifoliae* Baker emend. Cuatrec., considering that it produces solitary capitula at the apex of the branches, which often are grouped to form false capitulescences.

On the other hand, one species needs to be added to sect. *Aristidentes*, since it presents its typical features: *B. hirta* DC., from southern Brazil and Uruguay. This species was previously classified in the formerly heterogeneous sections *Trinervatae* DC. (Candolle 1836), *Cuneifoliae* DC. (Hooker & Arnott 1841), *Oblongifoliae* DC. (Baker 1882) and *Paniculatae* Heering (Heering 1904). With the 4 South American species added to sect. *Aristidentes* by Giuliano (2001), the number of species for the section becomes 11: *B. brevipappa* (McVaugh) G.L. Nesom, *B. hirta* DC., *B. lilloi* Heering, *B. malibuensis* R.M. Beauch. & Henrickson, *B. multiflora* Kunth, *B. plummerae* A. Gray, *B. polygama* Ariza, *B. pulchella* Sch. Bip. ex Griseb., *B. racemosa* (Ruiz & Pav.) DC., *B. serrifolia* DC., and *B. sordescens* DC.

Addition of species into sect. *Tubulatae*

Section *Tubulatae* was founded by Cuatrecasas (1967), who included 3 Andean species (*B. fraterna* Cuatrec., *B. granadina* Cuatrec., and *B. grandiflora* Kunth). Here it is considered necessary to add 5 species more, as they accord with the diagnostic features of this taxon: the Andean *B. auriculigera* Hieron. (previously placed into sect. *Trinervatae*; Hieronymus 1905), *B. huairacajensis* Hieron. (placed in sect. *Oblongifoliae* when originally described; Hieronymus 1901), *B. klattii* Benoist (never classified before), *B. volubilis* Kunth (formerly in sect. *Oblongifoliae*; Candolle 1836), and *B. maxima* Baker, endemic of the state of Rio de Janeiro in Brazil (placed in sect. *Oblongifoliae* when described; Baker 1882).

Another species, the Venezuelan endemic *B. zumbadorensis* V.M. Badillo, is

also placed here although staminate specimens are still unknown, since it has scandent habit, long conic hairs, reticulate-nerved leaves, large few-headed capitula, and large achenes, which fit properly in *Tubulatae*. The nine species of this section are mainly Andean in distribution.

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TWO NEW COMBINATIONS IN BOLIVIAN *GENTIANELLA* (GENTIANACEAE)[1]

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ABSTRACT

Gentianella boliviana and *G. inaequicalyx* are recognized as species and the nomenclatural combinations are validated.

RESUMEN

Se reconocen como especies *Gentianella boliviana* y *G. inaequicalyx*, y se validan las combinaciones nomenclaturales.

Two new combinations are required for identifications and for use in the *Catalogue of the Vascular Plants of Bolivia*, in progress at the time of this writing, edited by Peter Møller Jørgensen.

GENTIANELLA BOLIVIANA

Gentiana boliviana Pax, *G. hieronymi* Gilg, *G. lobelioides* Gilg, and *G. peruviana* (Griseb.) Gilg, which had been recognized as four species by Gilg (1916), were treated by Ho and Liu (1993) as a single species, which they called *Gentianella peruviana* (Griseb.) Fabris. Nomenclaturally, this treatment is incorrect. The name *Gentianella peruviana* (Griseb.) Fabris was based on *Gentiana limoselloides* [var.] β *peruviana* Griseb. The name *Gentiana peruviana* (Griseb.) Griseb. was based on this varietal name as to the basionym but not as to the plants described. When it was published in 1879, it was an illegitimate homonym of *Gentiana peruviana* Lam. 1786, which is a taxonomic synonym of *Centaurium cachanlahuen* (Molina) B.L. Rob. The name *Gentiana peruviana* (Griseb.) Gilg 1896 was based on *G. limoselloides* [var.] β *peruviana* Griseb. both as to basionym and as to plants described, but by typification was a superfluous combination. It likewise is illegitimate. There was no obstacle to the use of the epithet *peruviana* in *Gentianella* by Fabris (1958), but, as he recognized, the priority of the epithet *peruviana* at the rank of species, as applied to any of the *Gentianella* taxa discussed here, dates only from its use in this legitimate combination in 1958. The epithets *hieronymi*, *boliviana*, and *lobelioides* have priority at the rank of species in this context dating from their publication in

[1]Contribution No. 117 from the Royal Botanical Gardens, Hamilton, Ontario, Canada.

legitimate combinations in 1896, 1909, and 1916, respectively. Therefore, if the four taxa recognized by Gilg in 1916 are treated as conspecific, the correct name for the species thus circumscribed is *Gentianella hieronymi* (Gilg) Fabris. The name *Gentianella peruviana* (Griseb.) Fabris is correct only when the species to which it is applied is more narrowly defined, as it was by Fabris.

Within *G. peruviana*, Ho and Liu (1993) recognized two varieties: var. *peruviana*, in which they included *G. hieronymi* of Gilg (1916); and var. *boliviana* (Pax) T.N. Ho, which was equivalent to *Gentiana boliviana* plus *G. lobelioides* of Gilg (1916). Having studied nomenclaturally significant material of both taxa, I have chosen to recognize *G. boliviana* as a species rather than to consider it conspecific with *Gentianella hieronymi*.

Gentianella boliviana (Pax) J.S. Pringle, comb. nov. BASIONYM: *Gentiana boliviana* Pax, Repert. Spec. Nov. Regni Veg. 7: 243. 1909. *Gentianella peruviana* (Griseb.) Fabris var. *boliviana* (Pax) T.N. Ho, Bull. Nat. Hist. Mus. London, Bot. 23:64. 1993. TYPE: BOLIVIA. LA PAZ: Chacaltaya, 30 km from La Paz, 4800 m, *Buchtien 1482* (HOLOTYPE: B, destroyed; ISOTYPE: US, microfiche MO!).

Gentianella boliviana was further represented in my studies by *Beck 7477* and *8022* (HAM, [LPB]), *Menhofer X-2312* (HAM, [LPB]), *Solomon 5066* (MO), *Solomon & Moraes R. 13462* (MO), and *Ruthsatz 1057* and *1105* (both HAM). (Brackets indicate replicates not seen by me.) All of these specimens were collected near the type locality in Depto. La Paz.

Gentianella hieronymi is native to Provs. Jujuy and Salta, Argentina. The type collection is *Hieronymus & Lorentz 15* (HOLOTYPE: B, destroyed, photo F!; ISOTYPES: CORD, K!). It and *G. boliviana* are well separated geographically.

Gentianella boliviana and *G. hieronymi* differ as indicated in the following descriptions:

Gentianella boliviana (Pax) J.S. Pringle. Herbaceous perennial, 1–4 cm (including peduncles and flowers). Flowering stems usually only 1 or 2, occasionally to 6, decumbent, unbranched. Leaves all basal or cauline leaves 1 pair, all leaves narrowly obovate to linear-oblanceolate, 4–10(–16) × 1–4 mm, rounded or obtuse. Flowers solitary; peduncles 1–3 cm. Calyx 5–8 mm, lobed 0.45–0.55× its length, lobes narrowly obovate to oblong, rounded to obtuse or occasionally subacute. Corolla light blue with darker veins, widely campanulate, 10–16 mm, lobed 0.54–0.65× its length, lobes oblong-obovate, rounded at apex.

Gentianella hieronymi (Gilg) Fabris. Herbaceous perennial (?), 2–7 cm (including peduncles and flowers). Flowering stems usually 5–12, decumbent, unbranched. Basal leaves narrowly obovate to oblanceolate, 8–12 × 2–4 mm, obtuse; cauline leaves usually none, occasionally or 1 or 2 pairs, elliptic to linear, 6–10 × 1–2 mm, obtuse. Flowers solitary; peduncles 1–4 cm. Calyx 8–14 mm, lobed 0.45–0.65× its length, lobes oblong, rounded at apex. Corolla pale lilac, campanulate, 18–25 mm, lobed 0.52–0.60× its length, lobes elliptic-obovate, subacute.

Among the several low-growing, solitary-flowered species of *Gentianella* native to Depto. La Paz, *G. boliviana* is especially distinctive. The plants of this species are generally smaller than those of any other *Gentianella* species in La Paz. Its distinctive features include calyx lobes about as long as the tube, usually rounded at the apex, and corollas 10–16 mm long, with widely spreading lobes slightly longer than the tube, widely rounded at the apex ("obtusissimus" in the original description). The corollas of both of the specimens at MO were described as "pale blue" and those of *Beck 8022* as "verde-azul pálida." In herbarium specimens, this color, when well preserved, is reminiscent of that of *Amsonia tabernaemontana* Walter of North America, and is an instant guide to the recognition of *G. boliviana*. In the other solitary-flowered *Gentianella* species in Depto. La Paz the corollas are predominantly white, in most cases marked with dark blue-violet.

Gentianella hieronymi, which is not native to Bolivia, differs most conspicuously from *G. boliviana* in its larger, more floriferous plants; more narrowly campanulate calyces; larger, pale lilac, less widely opening corollas; and proportionately narrower corolla lobes that are subacute at the apex.

Many low-growing species of *Gentianella* with solitary- or few-flowered stems are present in Argentina, Bolivia and Peru, and not all of the taxonomic questions pertaining to these species can be resolved within a single paper. *Gentiana lobelioides*, now called *Gentianella lobelioides* (Gilg) Zarucchi, is known only from the type specimen, *Weberbauer 955* (holotype B, destroyed, photo F!), from Depto. Puno, Peru, directly across the border from Depto. La Paz, Bolivia. From my study of published descriptions and a photograph of the type its inclusion within *G. boliviana* seems reasonable. Notably, the corollas were described as "pallide-coerulei" (Gilg 1916), and those of the type specimen appear to have been ca. 11 mm long. However, since the type was in poor condition when photographed and I have encountered no specimens from Peru referable to *G. lobelioides*, its disposition is not within the scope of this paper. With *G. boliviana* (and probably *G. lobelioides*) excluded, populations referable, respectively, to *G. hieronymi* s. str. in Argentina and *G. peruviana* s. str. in Depto. Cuzco, Peru, are widely separated. These species were considered distinct by Fabris (1958), who emphasized differences in the proportionate lengths of the calyx lobes and tube as well as in corolla size. From descriptions (Gilg 1916; Fabris 1953, 1958) and photographs of the type specimens their recognition as separate species seems tenable, but since I have not seen specimens referable to *G. peruviana* s. str., further discussion of that species is not included here.

GENTIANELLA INAEQUICALYX

Ho and Liu (1993) included five species recognized by Gilg (1916) within their circumscription of *Gentianella silenoides* (Gilg) Fabris. They treated this species as comprising three varieties: var. *silenoides*, equivalent only to *Gentiana*

silenoides of Gilg (1916); var. *striaticalyx* (Gilg) T.N. Ho, within which they included *Gentiana striaticalyx* Gilg, *G. anthosphaera* Gilg, and *G. herzogii* Gilg; and var. *inaequicalyx* (Gilg) T.N. Ho, based on *Gentiana inaequicalyx* Gilg. The epithets *silenoides* and *inaequicalyx* both have priority at species rank dating from 1896, the other epithets from 1906 or 1916. Ho and Liu indicated that they had seen no specimens relevant to the typification of the epithets *silenoides*, *striaticalyx*, and *herzogii*, and cited no specimens that would exemplify their concepts of these taxa. They had seen isotypes of the names *Gentiana anthosphaera* and *G. inaequicalyx*.

I have examined photographs of the type specimens of all five of these epithets, as well as isotypes, paratypes, and more recent specimens from sites near the respective type localities that corresponded closely to the respective type specimens. My studies have in part supported Ho and Liu's revision, but have also indicated that some modifications would be appropriate. Specifically, *Gentianella silenoides* s. str. and the taxon treated here as *G. inaequicalyx* are distinctly dissimilar and conform well to standards for the recognition of species in South American *Gentianella*.

Gentianella inaequicalyx (Gilg) Fabris ex J.S. Pringle, comb. nov. BASIONYM: *Gentiana inaequicalyx* Gilg, Bot. Jahrb. Syst. 22:324. 1896. *Gentianella silenoides* (Gilg) Fabris var. *inaequicalyx* (Gilg) T.N. Ho, Bull. Nat. Hist. Mus. London, Bot. 23:64. 1993. TYPE: BOLIVIA. LA PAZ: Vicinis Sorata, 2650–3000 m, *Mandon 365* (LECTOTYPE, here designated, G, photos F!, NY!; ISOTYPES: GH!, K!, NY!, S, US!). PARATYPES: BOLIVIA. COCHABAMBA: Vic. Cochabamba, *Bang 1143* (GH!, K!, NY!); Cochabamba: Tunari, 3000–4000 m, *Kuntze s.n.* (probably B, destroyed).

Gentianella inaequicalyx was further represented in my studies by *Luteyn & Dorr 13799* (HAM, [LPB, NY]), from Depto. La Paz, Bolivia, and *Vargas C. & Cruz G. 4980* (HAM, [NY, USZ]), from Depto. Santa Cruz, Bolivia. Existing data indicate that the range of *G. inaequicalyx* is more northern than that of any of the other entities included in *G. silenoides* s. lat. by Ho and Liu.

The type of the name *G. silenoides* is *Lorentz & Hieronymus 877* (holotype B, destroyed, photo F!), from Depto. Tarija, Bolivia. This species was further represented in my studies by *Bastián 1183* and *1312* (HAM, [LPB]), *Ehrich 199* (HAM, [LPB]), and *Solomon 10197* and *10262* (HAM, [MO]), all from Depto. Tarija, Bolivia. It has also been reported from the adjacent Prov. Salta, Argentina (Fabris 1953).

Gentianella inaequicalyx and *G. silenoides* differ as indicated in the following descriptions:

Gentianella inaequicalyx (Gilg) Fabris ex J.S. Pringle. Herbaceous annual, 6–25 cm. Primary stem usually solitary, erect or curved only at base; branches all ± strongly ascending. Basal and proximal cauline leaves mostly oblanceolate to elliptic, 8–20 × 1–4 mm, obtuse, often absent at flowering time; distal leaves

gradually narrower, lanceolate to linear, 5–30 × 1–5 mm, acute. Inflorescence a dense cyme; flowers sessile or pedicels up to 1 cm. Calyx 6–15 mm, lobed 0.50–0.75× its length, lobes often distinctly unequal, linear, subacute. Corolla white with blue-violet tinge or blue-violet throughout, tubular-campanulate, opening narrowly, 11–22 mm, lobed 0.35–0.45× its length, lobes oblong-ovate, obtuse or abruptly short-acuminate.

Gentianella silenoides (Gilg) Fabris. Herbaceous annual, 8–30 cm. Primary stem usually solitary, erect or ± decumbent; branches widely spreading to ascending. Basal and proximal cauline leaves mostly elliptic, 8–20 × 1–4 mm, obtuse to acute, sometimes absent at flowering time; distal leaves gradually narrower, lanceolate to linear, 7–30 × 1–4 mm, acute. Inflorescence a diffuse cyme; pedicels 1–10 cm. Calyx 9–15 mm, lobed 0.55–0.95× its length, lobes usually subequal, narrowly linear, acute to acuminate. Corolla white to pale blue-violet, narrowly campanulate, opening ± widely, 15–26 mm, lobed 0.45–0.55× its length, lobes elliptic-ovate, acute to acuminate.

Plants of *G. inaequicalyx* are stiffly erect, with dense, many-flowered inflorescences in which the flowers are sessile or on pedicels less than 1 cm long. Its aspect, consequently, is similar to that of the North American *G. quinquefolia* (L.) Small. Its corollas are more narrowly tubular than those of *G. silenoides*, and are proportionately less deeply lobed. *Gentianella silenoides* differs in its diffuse inflorescence with widely separated flowers on pedicels 1–10 cm long, conforming to Gilg's (1916, in the key) description, "Flores in cymas laxas dispositi." Its aspect is consequently similar to that of another Bolivian species, *G. lythroides* (Gilg) Fabris ex T.N. Ho & S.W. Liu, which differs in its more deeply lobed corollas.

The other reductions to synonymy or varietal status within *G. silenoides* by Ho and Liu have been supported by my studies, in particular the reduction of *G. herzogii*. *Solomon 10262*, which, having corollas 28–36 mm long, would be identifiable as *G. herzogii*, and *Solomon 10197*, with corollas 15–18 mm long, in the size range given by Gilg (1916) for *G. silenoides*, were collected at the same locality in Depto. Tarija. They exhibit only modest differences in the size of the plants and in the size of the leaves, peduncles, and flowers, rather than any qualitative differences. The distinction between var. *silenoides* and var. *striaticalyx* (including plants recognized by Gilg both as *Gentiana striaticalyx* and as *G. anthosphaera*), is so slight that even varietal status might be questioned.

Further studies of taxa in this complex would be desirable. *Gentianella pallidolilacina* (Gilg) T.N. Ho & S.W. Liu was accepted as a distinct species by Ho and Liu (1993), but studies of additional material might indicate that it should be included within *G. inaequicalyx*. If these taxa were to be united (exclusive of *G. silenoides*) the epithet *inaequicalyx* would have priority.

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BOTANICAL SUMMARY OF A LOWLAND ULTRABASIC FLORA IN PAPUA NEW GUINEA

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ABSTRACT

The ultrabasic flora of the Kamiali Wildlife Management Area is described from a recent series of floristic surveys. The general account and checklist also incorporates information from earlier collections. Two new species are presented: *Psychotria bulilimontis* (Rubiaceae), and *Trichadenia sasae* (Salicaceae). Other taxa of special interest are briefly discussed.

KEY WORDS: botanical survey, serpentine, ultrabasics

JAPANESE ABSTRACT

カミアリ野生生物管理区の超塩基性植物相について、最近行われた一連の植物調査の結果から記述する。初期に行われたパプア超塩基性ベルト地帯での採集調査結果もモロベ州南部の低地蛇紋岩地域の調査結果と共に総合的に扱った。2つの新種、*Psychotria bulilimontis* (アカネ科)と*Trichadenia sasae* (イイギリ科)について発表するとともに、特に興味深い他の分類群についても簡単に記す。

キーワード：植生調査、蛇紋岩、超塩基性土壌

INTRODUCTION

After more than a century of scientific publication on the Papuasian flora, the ultrabasic (i.e. ultramafic or serpentine) vegetation of Papua New Guinea (PNG) is still largely unknown in spite of its unusual qualities. Multidisciplinary surveys were initiated in 1997 to address the need for information from such areas, using the Kamiali Wildlife Management Area (KWMA) as a focal site for biodiversity assessment (Figs. 1–2). The selected location offered a number of unique advantages among comparable PNG environments, as it included a complete elevational sequence of natural-growth habitats from sealevel to cloudy summits, and its exploration could be conducted with cost-effective itineraries. In the following narrative, botanical results from the recent investigations are presented and integrated with earlier work in the Papuan Ultrabasic Belt.

HISTORICAL BACKGROUND

The first collections from southern Morobe were made in the Waria drainage (Fig. 3) by R. Schlechter (in 1908; see Schlechter 1911–14) after which there was a general neglect of the district until the NGF/LAE collections of the former Department of Forests. Most of Schlechter's specimens were later lost during the WWII destruction of the Berlin Herbarium. In 1990, Clements rediscovered

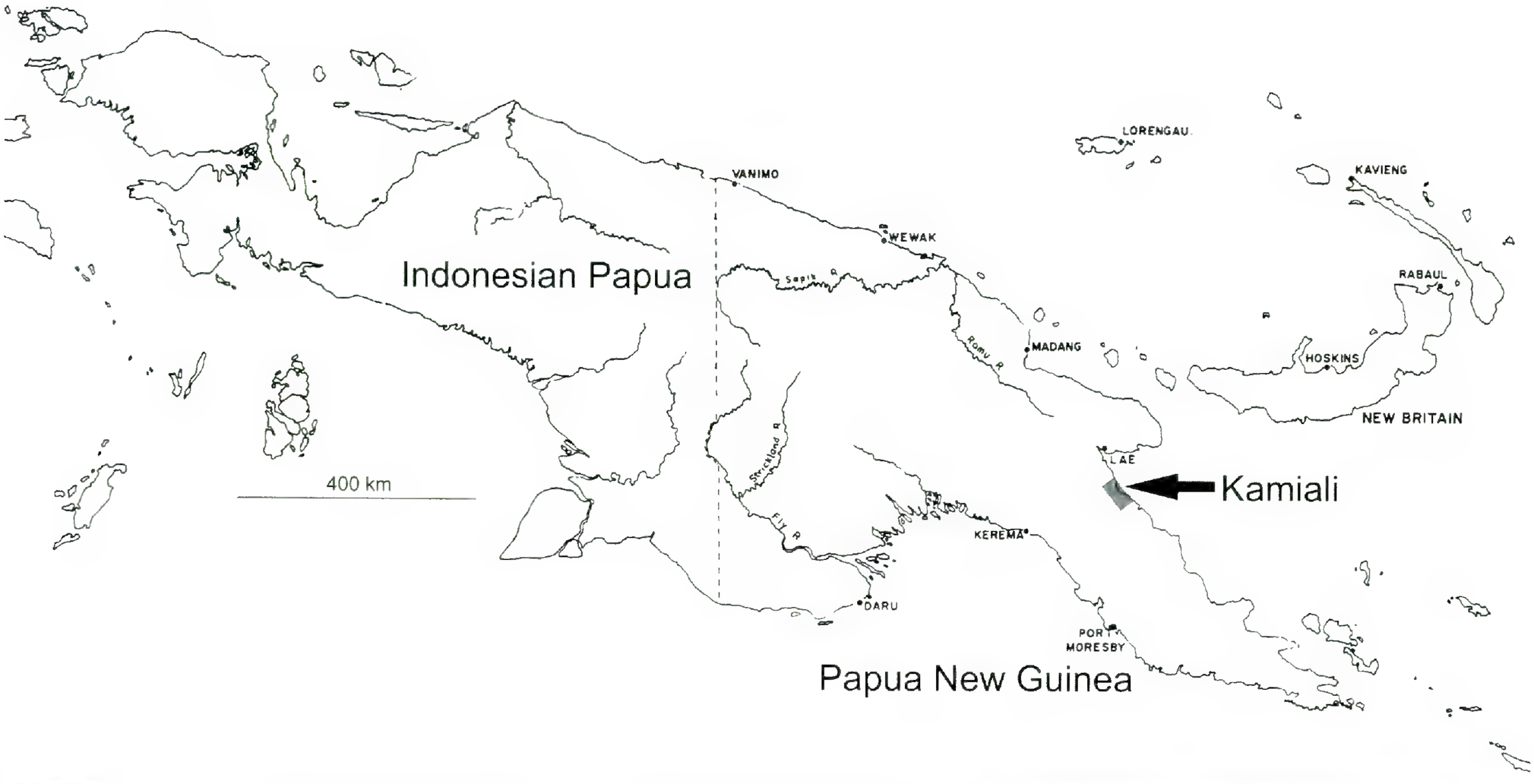


FIG. 1. Island of New Guinea. Shaded area: lowland interval of the Papuan Ultrabasic Belt. Arrow: Kamiali village.

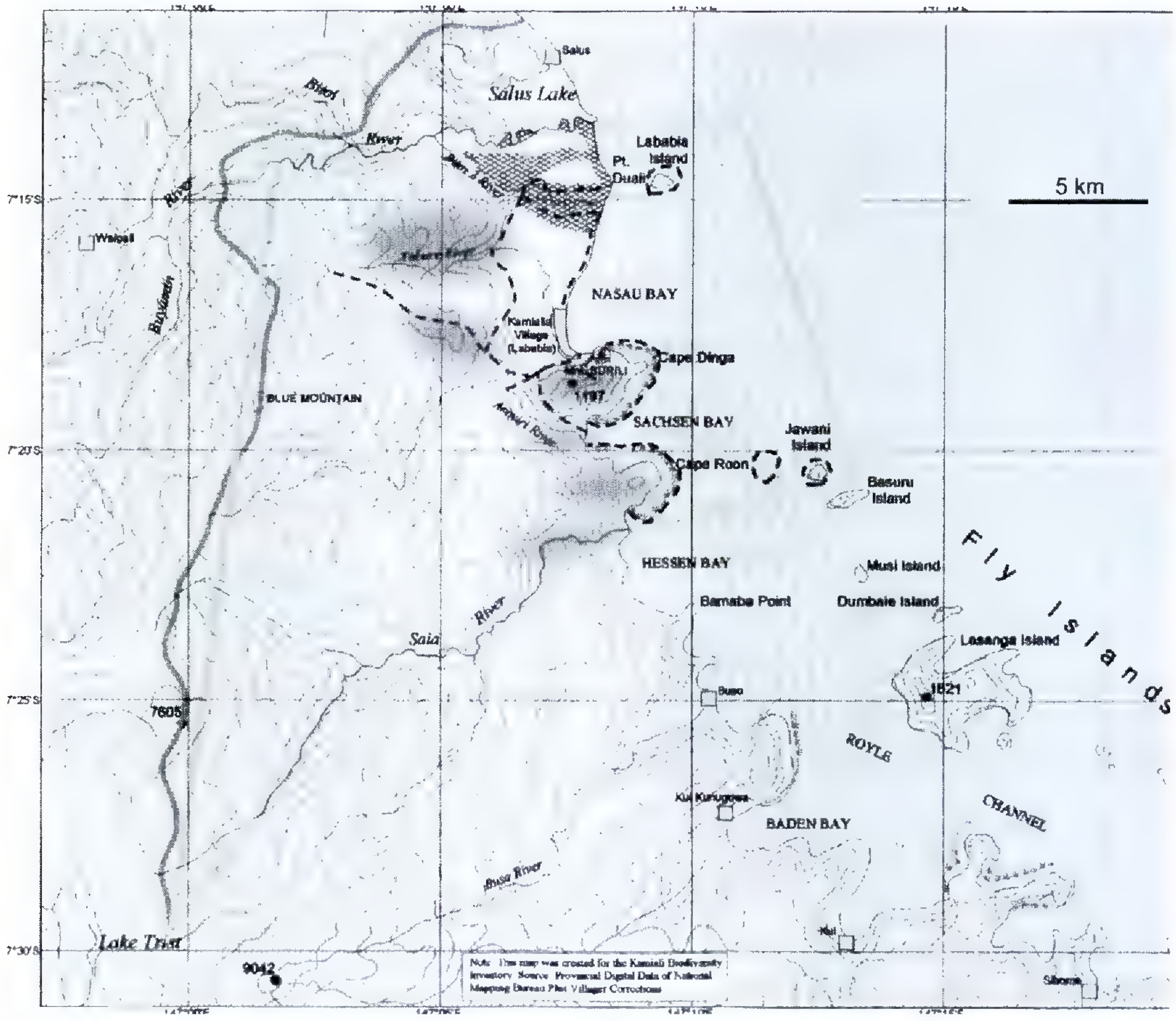


FIG. 2. Kamiali Wildlife Management Area (KWMA). Light-colored perimeter: KWMA gazetted boundary. Darker-colored perimeter: customary lands claimed by the Kamiali people. Shaded elliptical areas: principal survey sites. Contours: 250′, 500′, 1000′, then subsequently in increments of 1000′. Adapted from Village Development Trust file map.

several of the lost German taxa and described some new ones (Clements & Ziesing 1990). Exploration of nearby Natter Bay (e.g. by Croft in 1976) also yielded interesting new material (Fig. 4). Since 1908 there has otherwise been little collections activity between the Waria River and Paiewa (Paiawa).

Particularly during the 1970s, the area around Buso was used as a training site by the Bulolo Forestry College (now Bulolo University) and many specimens were taken during periodic visits by expatriate botanists of that general period (*inter alia* B. Conn, D. Foreman, A. Gillison, E. Henty, M. Jacobs, A. Millar, C. Ridsdale, and H. Streimann). Although the Buso locality is thus relatively well documented in comparison to adjacent areas, it was later despoiled by logging subsidiaries of Rimbunan Hijau. Confronted by mounting environmental concerns from landowners and advocacy groups, the last logging company (Timber Products Marketing Corporation) was forced to leave in 1995, but by



Fig. 3. A typical non-ultrabasic forest in the alluvial zone of the Waria River.



Fig. 4. Natter Bay. Coastal ridges dominated by remnant stands of *Anisoptera thurifera* ssp. *polyandra*.

then an extensive territory between Buso and Morobe Bay had been harvested by commercial operators (Fig. 5).[1] Athough remnant *Anisoptera*-dominant stands are still scattered along the S Morobe coast (e.g. at Siboma or 'Simpoma'), most of the low elevation forests are currently in early successional recovery. The Kamiali Wildlife Management Area (KWMA) is now the only significant primary-growth habitat in the Huon electorate southeast of Lae.

In 1992–1993, the villages of SE Morobe (i.e. Kamiali, Buso, Kui, Siboma, and Paiewa) developed a cooperative proposal for environment-sensitive alternatives to the concessional logging which was then occurring (Zibe-Kokino 1993). Known as the Lasanga Island-Lake Trist Conservation Project, the initiative was based on the principles of Integrated Conservation and Development (ICAD), an economic model which promotes smallscale enterprise as a substitute for ecologically-disruptive activities.

Since its early beginnings at Crater Mt, the ICAD methodology has developed into the principal present-day mechanism for environmental conservation in PNG, as evidenced by the growing body of literature produced by its proponents (e.g. James 1996; Johnson 1997; McCallum & Sekhran 1997; Pearl 1994; Saulei & Ellis 1998; Wagner 2001a, in press). Several major programs are currently being implemented under the ICAD format, most notably by testbed projects in the Adelbert Mts, Crater Mt, Hunstein, Kamiali, Kikori, Milne Bay, and Tonda. However, some conspicuous failures have occurred (McCallum & Sekhran 1997).

Many issues and problems encountered at other ICAD localities were also experienced by the Lasanga-Lake Trist initiative, in particular the inability of stakeholders to achieve a consensus as each clan group fought to maximize its own benefits. After the original design for a 250,000 ha easement was compromised by funding difficulties, the proposal was recast as a 47,000 ha conservation area including only the Kamiali territory (Anon. Sept. 19, 1996). This reduction in scope enabled the project to proceed by focusing participation on a more homogeneous combination of landowners, but at a probable loss in protection of biodiversity values.

The present KWMA is a linked land-sea conservation zone, of which only 29,285 ha is terrestrial environment (ibid.). While there is little consensus on the minimum size requirement for protected areas, it is unlikely that the existing KWMA is large enough to serve as a stand-alone conservation unit. The self-sustainability of biotic communities arguably requires significantly larger territories, especially in view of the destructive effects of probable disturbance

[1]Additional timber production blocks were subsequently proposed by the National Forest Plan (Anon. 1996) for Salamaua, Lake Trist, and Waria Valley. Placed in abeyance by a country-wide forestry moratorium, the prohibitions against new logging projects were recently lifted. However as a result of the logging damage from previous years, it will be difficult for industrial operators to reenter the general area, in part because of the environmental advocacy now conducted by organizations such as VDT.

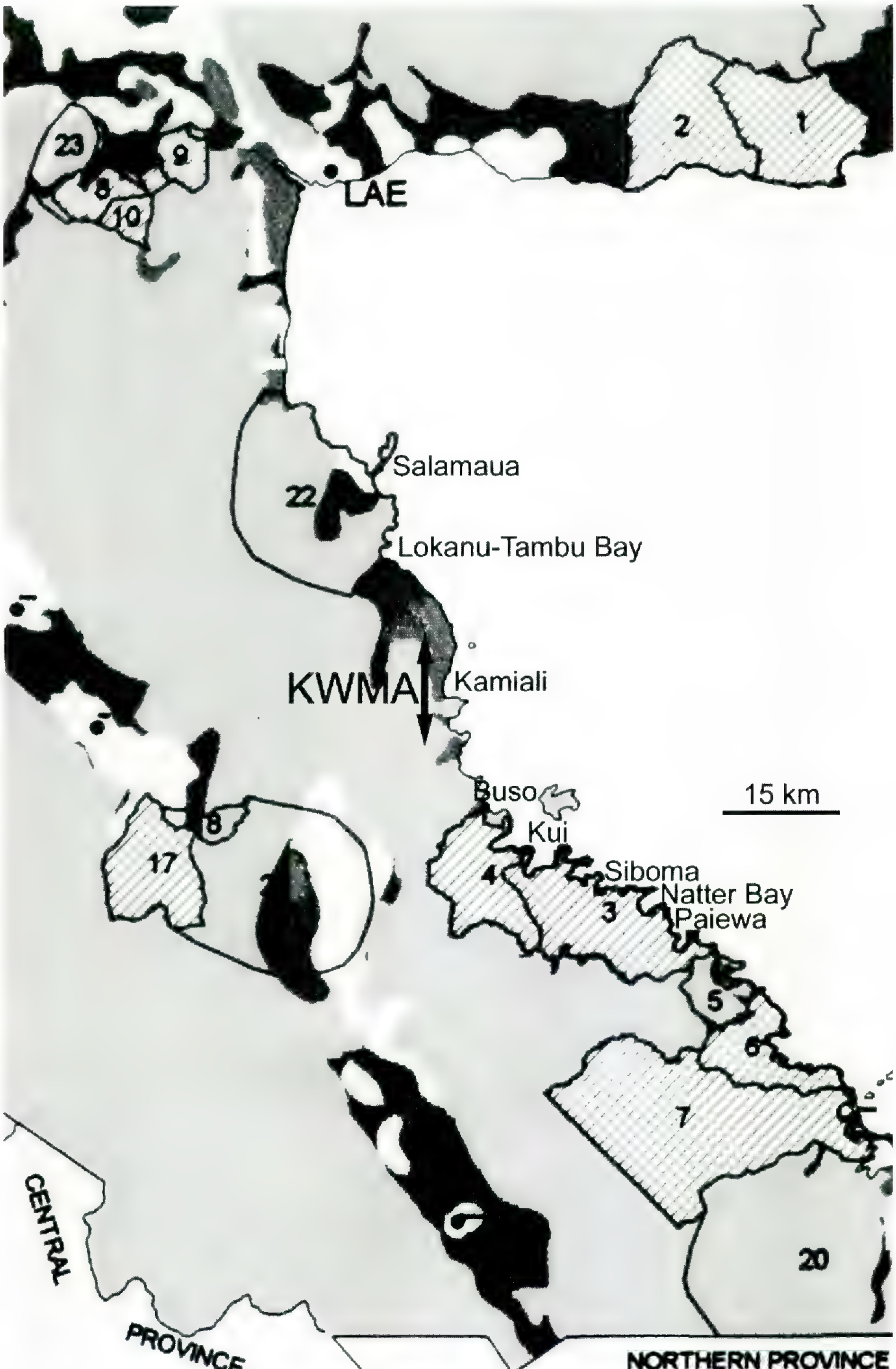


FIG. 5. Forest production areas in south Morobe (striped blocks 3–7). 3. Kui Buso TP (Timber Purchase); 4. Kui Buso extension TP; 5. Maiama-A TP; 6. Maiama-B TP; 7. Morobe TP. Other localities from the text are also indicated. The Waria River (not shown) is near the boundary between Morobe and Northern Provinces. Adapted from Anonymous (1996).

mechanisms such as cyclonic storms and El Niño events. In depauperate forests with monodominant canopies (e.g. Hawaii), a complete suite of species and forest successional stages can be encompassed by tracts as small as 100–200 ha (Mueller-Dombois 1980). But New Guinea floristic environments are among the richest in the paleotropics, and the minimum-area requirements are several orders of magnitude higher. Jeffries (1996) for example, gives 50,000 ha as a lower limit for biodiversity protection, while Beehler and Alcorn (1993) go as high as 800,000 ha. Even within that wide interval, the existing Kamiali easement falls substantially under target. Against this background, the impending expansion of the KWMA to a southern boundary near Paiewa will help to address some of the biological requirements implicit in ICAD design. Sanctioned by local communities in 2002, the new development will bring ca. 300,000 ha of terrestrial environment under conservation management (Kisokau & Siga, pers. comm. Feb. 2003).

Although traditional cultures in PNG are often depicted as being based on consultation and consensus, achieving a determination of common purpose or directed action is never easy. Centrifugal forces are powerful in local politics, as clan, subclan, and kinship self-interests are more important than any perception of the common good (Martin 1998). Expansion of ICAD operations from Kamiali into adjacent territories is certain to aggravate the difficulties inherent in management of customary lands. Those same problems previously led to the polarization of the original Lasanga-Lake Trist conservation plan. The successful resolution of conflicts arising from parochial motivations will determine the effectiveness of the enlarged VDT conservation area at Kui-Siboma and of possible future expansion along the coastal corridor to Oro (Northern) Province. Whether this can actually be achieved within the context of the ICAD philosophy is very much an ongoing issue of considerable future significance to conservation in PNG.

The Physical Environment

Climate.—The KWMA lies mostly within Morobe's lowland and premontane climatic zones, where the mean annual rainfall is 3,000–4,000 mm. The wettest months generally occur during January–April, when prevailing winds are northwesterly, and the driest in May–August when the winds are replaced by southeasterly trades (McAlpine et al. 1983). Even during the dry season, mean monthly rainfalls are generally around 200 mm, and the vegetation is rarely subjected to water shortages under normal circumstances (ibid.: 140). Most climatic classifications would describe the project sites as tropical everwet or perhumid, reflecting the overall absence of moisture deficits.

In the western Pacific, El Niño oscillations are typically accompanied by severe droughts in rainforest environments like the Bowutu Range. During the 1997–98 disturbance, coastal tracts adjacent to the KWMA were subjected to

devastating fires which destroyed substantial areas of forest (Fig. 6). Formerly covered with primary growth, Lasanga burned out of control during the 1997–98 drought and is now a weedy island. In marked contrast to the El Niño episodes, the periods of peak rainfall are often accompanied by severe flooding in the lowlands and numerous landslides on higher slopes. In 1999 the La Niña rains resulted in torrential surges along the main rivers emptying into Nasau and Sachsen Bays, completely destroying the subsistence gardens on the Bitoi Delta. As the KWMA rivers overflowed their banks, the flood waters flattened wide channels through the surrounding alluvial forest. The botanical team subsequently enjoyed unprecedented access and easy collecting along the corridors of felled canopy, which years later, are now becoming clogged with impenetrable thickets of *Calamus*.

Geology.—Much of New Guinea's diversity has been shaped by a complex and dynamic geological past. Although the southern part of the island is an extension of the Australian craton, the northern districts are a melange of former island arcs which rafted onto the mainland during the northward migration of the Australian landmass (Dow 1977; Jaques & Robinson 1975; Pigram & Davies 1987). The Papuan Peninsula, consisting of the SE-trending 'tail' of New Guinea, represents the remnants of an accreted arc (Hamilton 1979).

The Bowutu Range forms a major portion of the Papuan Peninsula and is also PNG's most extensive elevational series of ultramafic landscapes (Dow & Davies 1964). This general region is part of a terrane complex paleohistorically distinct from the rest of northern New Guinea, having docked with the mainland ca. 10 m.y. after the Sepik terranes (Pigram & Davies 1987). The area's unusual geology has led to its recognition as a separate physiographic province, extending from the Kamiali coastline to the craggy summits of the Owen Stanley Range (i.e. the Papuan Ultrabasic Belt, cf. Bain 1973; Löffler 1977; Thompson & Fisher 1965). Between Lokanu-Tambu Bay and Kui village, the ultrabasic belt forms a continuous series of lowland environments. The offshore islands such as Lasanga and Musik are part of a different (nonserpentine) geological series reaching southwards to the Waria River (Dow & Davies 1964) and are excluded from consideration in this paper.

Soils.—Ultrabasic environments are characterized by substrates low in silica, but with high magnesium and iron contents. In addition to deleterious magnesium/calcium ratios, ultrabasic soils are frequently associated with phytotoxic concentrations of nickel, chromium, and cobalt (Brooks 1987; Whitmore 1975). The influence of heavy metals is often cited as being responsible for the stunted vegetation of serpentine habitats, though it should be noted that low-statured canopies are not an invariable feature of ultramafic forests (see Fox & Tan 1971; Proctor et al. 1988).

Bowutu populations from at least one species [*Rinorea bengalensis* (Wall.)



FIG. 6. Bulili Ridge. Forest burn from the 1997–98 El Niño drought.

O.K.], are known to accumulate nickel (Brooks 1987). There are no reports of heavy metal accumulation in other native plants. A brief discussion of serpentine floras in New Guinea is provided by Brooks (ibid.), Paijmans (1976), and van Royen (1963), but there is a conspicuous absence of floristic data in such accounts. A summary of ultrabasic vegetation is otherwise available for the tropical far east (Proctor 1992). While it is generally recognized that ultrabasics are associated with depauperate canopies easily discerned in aerial photographs (Paijmans 1976), the species composition of the communities remains poorly known for Papuasia. Comparative studies from Western Malesia show wide variation in the structure and endemism of such floras (Proctor et al. 2000).

Ultrabasic terrain in PNG is characteristically composed of massive ridges with uniform slopes and unstable soils (Löffler 1977; Paijmans 1976). The topographic instability of the study area is reflected in the presence of old landslip scars on many mountainsides (Figs. 7–8). Earthquakes with shallow epicenters are common in northern New Guinea (Hamilton 1979), and can aggravate local tendencies for landsliding. Quake-triggered landslides have been responsible for many fatalities in Morobe Province.

The KWMA hill habitat is unsuitable for agriculture (Bleeker 1975a, 1975b) because of erosion hazards and the general infertility associated with serpen-



FIG. 7. Sachsen Bay. Landslide behind mangrove community.

tine substrates. In contrast, the flood plain of the major streams (Bitoi, Tabali, Arawiri, and Saia),[2] have deep deposits of organic alluvium (Fig. 9). The Bitoi Delta between the Areta (N) and Daunawa (S) branches is a particularly fertile tract in which nearly all the Kamiali food gardens are concentrated. Unlike many Highlands areas where intensified cropping has led to lowered productivities (see Levett & Bala 1995), the KWMA agricultural system has surplus capacity capable of supporting twice the present population (Bein et al. in press, in submission). The high productivities are due to the presence of rich delta soils and their renewal by seasonal floods (ibid.).[3] These factors have enabled the adoption of a shortened 7-year garden cycle (vs. an estimated 20 years in normal slash and burn rotations). At current rates of population increase, the existing subsistence system can probably satisfy local needs for 35 more years without any expansion in area (Wagner 2001b).

The Social Environment

The total population of Kamiali was 520 in August 1997. There are two major

[2] On contemporary maps the Arawiri (Ariwiri) is shown as the Alealer River, and the Saia as the Sela River (Rova Australian Survey Corps Series T601, Nasau sheet 8383, Edition 1 AAS, 1:100,000)

[3] Martin (1998) specifies a Bitoi crop rotation of 3–4 years and suggests the standard rotation period at nearby Kui village is 10–15 years. Levett and Bala (1995) give 7–20 years as the standard swidden cycle for PNG



FIG. 8. As for figure 7, showing the successional community. The seral taxa include mainly *Dicranopteris linearis*, *Machaerina glomerata*, *M. rubiginosa*, *Myrtella beccarii*, and *Stenocarpus moorei*.



Fig. 9. Saia River. Several new fish species have been discovered in the clear-flowing streams of the KWMA.

clans, the Gara and Tabali, and at least 12 subclans (Martin 1998, 1999). Kela is the indigenous tongue, one of approximately 200 comprising the Austronesian language group of northeastern New Guinea (McElhanon 1984; Wurm 1985). Nearly all villagers also speak the lingua franca of PNG (i.e. Tok Pisin). With the recent establishment of a community school, most children have acquired at least some understanding of English.[4]

Seemingly unstructured to western observers, local village life is actually governed by an extensive network of customary practices and expectations. Inheritance and property rights are matrilineal by tradition, but considerable change is occurring as a result of exposure to modern influences. Martin (1998, 1999, 2001) and Wagner (2001b) provide an informative discussion of social developments in their specific connection to conservation.

Despite their retention of customary lifestyles, Kamiali inhabitants are surprisingly sophisticated and informed, a direct result of the quality-of-life improvements introduced by the Village Development Trust within the past 10 years. Several community leaders for example, are computer literate and maintain international email contacts from VDT's offices in Lae. As another sign of

[1]There are 6 principal Kela-speaking villages on the Huon coast, divided into two apparent dialect groups. Kamiali has its closest linguistic and kinship affinities to the hamlets of Buso and Kui immediately to the southeast, the latter centers having been established by migration of Kamiali settlers during a former time of epidemic (Martin 1998)

cultural change, researchers are required to establish a Memorandum of Understanding with village-appointed representatives, disclosing the purpose of an intended study and affirming its obligations to the Kamiali people.

The KWMA villagers are dependent on marine resources for their livelihood (mainly reef fishing) supplemented by a limited range of garden crops. Cash incomes are small and sporadic, on a household basis typically falling between PGK 500–4,000 per year (at current rates 1 PGK=0.25 USD), mostly from the sale of fish, sea shells, and betel nuts (Martin 1998; Wagner 2001b). Although the Kamiali territory consists predominantly of primary forest rich in animal life, only three individuals from the village population (Enok Nasa, Tani Jena, Tom Ziena) are known to actively hunt wild game such as cuscus, pigs, cassowaries, and wildfowl. For a people with copious forest resources, remarkably little use is made of the terrestrial environment. Even among the small hunting fraternity, forest forays are apparently undertaken mainly for recreation, and overnight trips are rarely attempted. To a certain extent, the apparent avoidence of inland habitats may be due to a belief in animalism and spirits (masalai), even though all villagers profess devotion to the Christian (Lutheran) faith. For whatever reason, there is essentially no human presence in the interior areas above 500 m. Since subsistence farming is confined to the flood plain on the Bitoi Delta (a tract of ca. 460 hectares), human impacts on the environment are practically nonexistent (Martin 1998; Wagner 2001b).

The Logistical Environment

In geographic regions with the environmental qualities of New Guinea, investigators have little difficulty identifying biologically suitable localities for botanical research. During the selection of potential study sites, the logistical limitations imposed by poor civil infrastructures often take precedence over the biological concerns. When viewed in this context, the KWMA offers a particularly attractive combination of site attributes.

In addition to exceptional floristic quality, the coastal location of the KWMA and its proximity to Lae (the second largest city in the country) provide researchers with unusually cost-effective logistics. There is no other conservation locality in PNG offering equivalent accessibility and scientific value in one package. While many natural areas are of similar interest, their remoteness and associated travel costs discourage longterm study. Although the KWMA has no roads or airstrips, the site can be conveniently reached by outboard-equipped dinghies ('speedboats').[5]

On the shores of Nasau Bay the Village Development Trust maintains a permanent training center, guest houses, on-site staff, wireless communications, and sea transport. Primary forest is immediately adjacent to the accommodations,

[5]Travel time is 2.5 hours from Lae by 40 hp outboard and 1.5 hours by 70 hp. Charter rates for 40 and 70 hp speedboats are PGK 600 and PGK 800 respectively (roundtrip Lae-Kamiali).

allowing easy access to serpentine vegetation. With electric generators for the facilities available on continuous standby, researchers are able to live and work under conditions conducive to high morale and productivity. Of particular importance to scientists using customary lands, access and intellectual property issues have been successfully negotiated via VDT-brokered agreements with local landowners. In recognition of these infrastructural advantages, the KWMA was selected as the principal PNG site for elevation-sequenced studies in the Pacific-Asia Biodiversity Transect network (PABITRA; Takeuchi 2003a, digital images on http://www.senckenberg.uni-frankfurt.de/odes/).

In conformity with the ICAD concept, ecotourism is actively encouraged as an environment-friendly enterprise within the conservation zone. Kamiali's scenic shoreline of white-sand beaches is currently a featured scientific attraction, with nearly 5 km of waterfront serving as active nesting sites for the endangered leatherback turtle. Substantial numbers of science-oriented visitors arrive during the haul-out season in November-March to observe the turtle tagging operations (Kisokau & Dutton 2002; Lindgren 1999a). In marked contrast to the spartan conditions at most research venues, the KWMA's ambience and infrastructure are comparable to a vacation resort.

Kamiali's checkered history forms a colorful backdrop to these present-day assets. During WWII Nasau Bay was the site of a major battle between Allied and Japanese forces (see Lindgren 1999b, 2000, for a popular account), and many war artefacts, including aircraft and ordnance, are still present in the area (Figs. 10–11). Local guide services are available at modest cost to tourists and other visitors.

The Biotic Environment

Although Paijmans (1976) believed that no native plants are restricted to ultrabasics, there is mounting evidence that such substrates are in fact associated with substantial endemism. In addition to the presence of localized endemics, serpentine environments are also noted for distributional anomalies, particularly by taxa occurring at elevations far below their usual centers. This pattern is especially pronounced on the Bowutu ultrabasics, where the *Massenerhebung* effect of coastal mountains (see Grubb 1971; Grubb & Stevens 1985; Whitmore 1975) combines synergistically with substrate effects. Many low-elevational records can be expected from such situations, since the KWMA is PNG's only conservation locality where serpentine communities are disposed in a continuous sequence from sealevel to cloudy summits.

Nearly all information from Bowutu environments are from easily-studied coastal localities. The montane and inland areas have been neglected despite their presumed biotic significance. In recognition of these deficiencies, the Bowutu Range is included among PNG's 16 terrestrial unknown areas and as one of the five most critical watersheds requiring conservation action (Sekhran



FIG. 10. Unexploded US 500 lb GP bomb from the KWMA. Explosives recovered from WWII-vintage munitions are often used in near-shore fish dynamiting, a practice implicated as a principal cause of reef damage and declining fish stocks. Such bombing is illegal in PNG and is also outlawed under the KWMA's organic rules (Anonymous, Sept. 19, 1996), but the prohibitions are not vigorously enforced. Photo Karol Kisokau.

& Miller 1995). Johns (1993) had listed the district with 42 other localities of greatest floristic importance for PNG. The estimate of 4,000+ plant species for the area is among the highest of any existing conservation site (ibid.).

In 1997 a multidisciplinary survey was concluded within the KWMA, focusing primarily on marine and land-fauna documentation (Bein et al. 1998; Bein 1999). The botanical inventory started in 1998 immediately after the animal surveys had ended. Taken collectively, the biotic assessments have examined coastal and alluvial swamps, lowland rainforest, premontane foothill forest, and mossy cloud forest. The collections density (CD: 890 plant specimens per 100 sq km) is very high by Papuasian standards, but this figure is misleading because much of the collecting has been confined to the lowlands.[6] The montane communities are still poorly known, even though most of the floristic diversity is probably concentrated at the higher elevations. Approximately 20 new plant species have been discovered during the ongoing investigations (Huynh 2001, 2002; Pipoly & Takeuchi in submission; Stevens in submission;

[6]The overall CD for Papuasia is only 30 collections per 100 sq km (Frodin 1990). The atypical nature of the Kamiali sampling coverage is evidenced by the near-absence of collections from above 500 m elevation. In other PNG environments, the montane areas are usually much better known than the lowland habitats.



FIG. 11. Rusting 81 mm mortar shells from the KWMA. In 1943 Nasau Bay was the site of an amphibious assault by the US 32nd Division and a land attack from Wau by the Australian 32 Bde (Burns 1991). Photo Karol Kisokau.

Takeuchi 2001, 2003b). The findings obtained to date provide evidence of a continuing potential for discovery in one of PNG's most distinctive floristic environments.

MATERIALS AND METHODS

In contrast to Rapid Biological Assessments, the botanical survey was based on a plan involving numerous visits to the KWMA. Fieldtrips of 1–2 weeks duration were conducted at ca. 4 month intervals during the 4-year survey. With a schedule of repeated visits, fertile specimens were acquired throughout the year, and even infrequently-flowering taxa could be collected. Because of the KWMA's logistical advantages, studies employing such itineraries can achieve a more complete and cost-effective coverage than efforts based on single visits. The benefits of conducting small-area inventories over extended periods of time have been discussed by earlier commentators (e.g. Prance 1977).

Forest communities were examined by walk-through collecting and visual assessment, operating either from campsites established in the bush, or from the KWMA science facilities at Lababia Ridge and Kulindi (Figs. 12–14). The explorations were generally confined to the lowland zone below 500 m. Plant collections were usually made in sets of 3–5 duplicates, but if a specimen was believed to have special significance, this was increased to ca. 10 duplicates. At



FIG. 12. Parataxonomists collecting along the Saia River.

the Kulindi Science Center, electric generators enabled gatherings to be dried by artificial heat immediately after collecting in adjacent forests. Otherwise when operating from bushcamps, the gatherings were field-pressed in newsprint and plastic bags, then soaked with 70% ethanol for subsequent processing in Lae (Fig. 15). Silica-dried samples for DNA sequencing were also obtained if specialists had placed earlier requests for assistance.

In Appendix 1, the survey specimens have been tabulated together with earlier numbers from the ultrabasics at Buso and Kui.[7] The ultrabasic boundary extends southeast from Kui village, passing immediately inland from Braunshweig Harbor at Siboma (Simpoma). Specimens from Kui are appended with a (K) on the checklist, to indicate when the material is from the ultrabasic boundary and may have been obtained from non-serpentine terrain. Natter Bay and Paiewa represent Tertiary substrates of different age and origin from the Bowutu ultrabasics (Dow & Davies 1964), and are thus omitted from the compilations.

The Paiewa drainage is intersected by an extensive network of logging tracks along which a few collections were made under the NGF series (e.g. *Gillison NGF 22489–22500, 25011–25049*). Some of the upstream areas at Paiewa are inside the ultrabasic belt, but the locality data are too ambiguous to determine the substrate status of such collections. Jacobs's numbers from 'opposite

[7]Author citations for binomials are provided in the text for names which are not in the appendix.



FIG. 13. Bulili Ridge. Survey team in ultrabasic forest.



FIG. 14. The Kamiali Science Center facilities at Kulindi, on the beachfront of Nasau Bay. Natural-growth ultrabasic forest is immediately adjacent to the compound. A substantial number of undescribed taxa have been discovered in the general area.

Lasanga Island', are similarly difficult to interpret with respect to their substrate association.

Much of the methodology and rationale for the Kamiali surveys have been discussed elsewhere (Takeuchi 2003a). As with many recent efforts, the itinerary was implemented by village teams involving institutional parataxonomists D. Ama, Nathan, and/or A. Towati, or as a larger workforce supervised by colleague B. Siga and the writer.

GENERAL DESCRIPTION OF THE VEGETATION

The physiognomy of the KWMA lowland flora is similar to a montane forest, with a preponderance of small-leaved species and a general absence of vining, cauliflorous, or compound-leaved plants (Fig. 16). Plank-buttressed trees are rare. To some extent, these characteristics are due to the anomalous presence of higher-elevation species in lowland habitats. Many sealevel distributional records were documented by the recent surveys (e.g. see discussion on *Astronidium morobiense*).

The KWMA regrowth phase (between sealevel to at least ca. 500 m elev.) is dominated by *Commersonia bartramia*, *Decaspermum bracteatum*, *Dicranopteris*

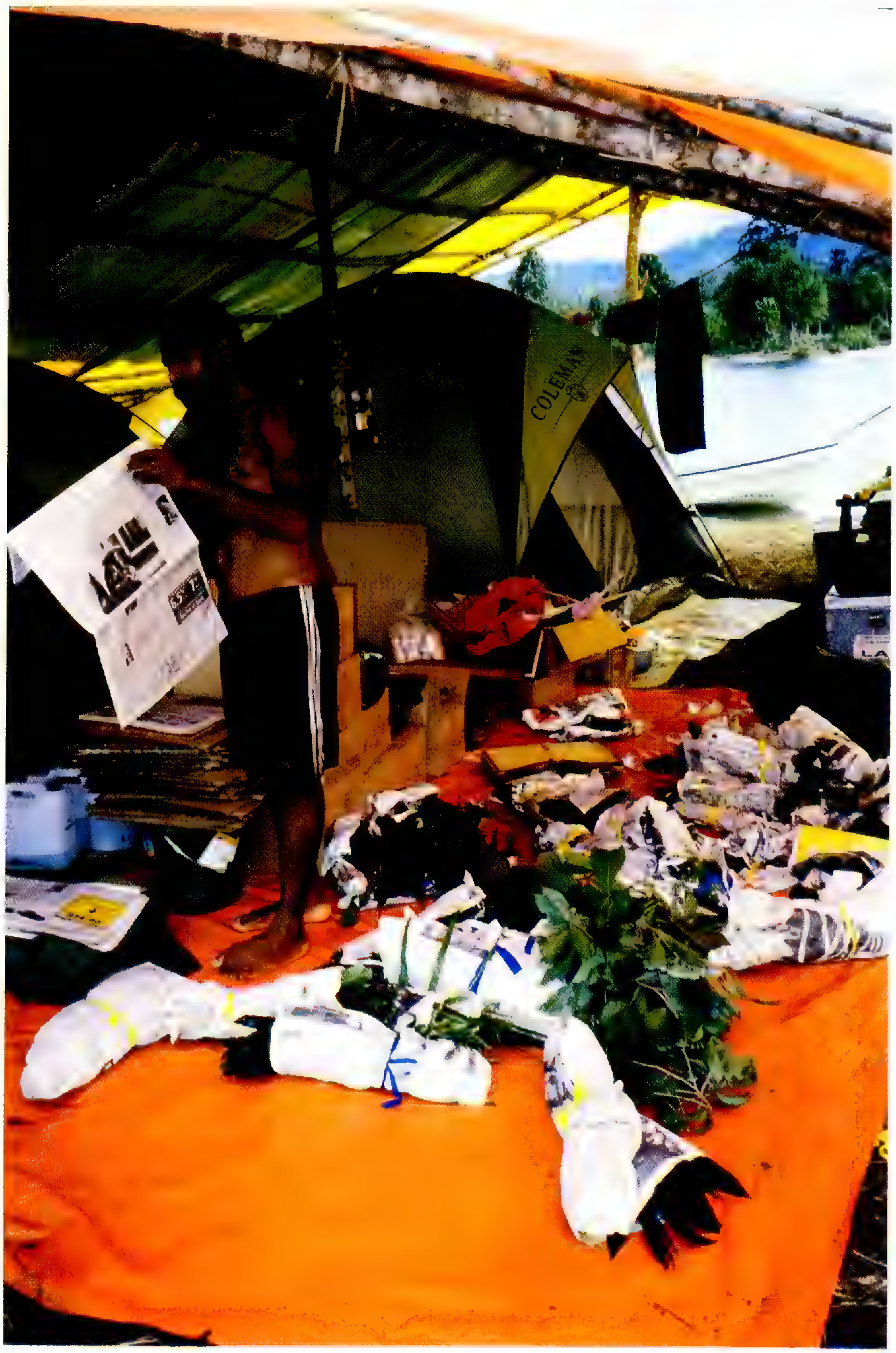


FIG. 15. Processing of plant specimens in the field. Gatherings are individually wrapped in newsprint to protect the collections during the trek back to basecamp, where they are then packed in ethanol.



FIG. 16. The Bulili ultrabasic forest extends to the highwater line on Nasau Bay.

linearis, *Myrtella beccarii*, *Schuurmansia henningsii*, and *Timonius paiawensis*. Many of the seral or pioneer taxa normally found in Mamose environments are absent or uncommon.[8] *Cyathea*, *Cypholophus*, *Dendrocnide*, *Endospermum*, *Glochidion*, *Gouania*, *Leea*, *Macaranga* (except for *M. bifoveata*), *Mallotus*, *Musa*, *Mussaenda*, *Omalanthus*, *Pipturus*, and *Trichospermum* are conspicuously missing or are insignificant in the floristic succession on ultrabasics (Fig. 17). Even the aggressive weed *Piper aduncum* rarely manages to establish in seemingly opportune situations. Similar patterns have been noted in the Raja Ampat serpentine district of Irian Jaya (Takeuchi 2003b).

Within the lowland ultrabasic flora as a whole, a number of ordinarily speciose families are clearly under-represented. The impoverished groups include Araceae, Begoniaceae, Combretaceae, Dilleniaceae, Gesneriaceae, Malvaceae (sens. str.), Marantaceae, Moraceae, Urticaceae, Verbenaceae, and Vitaceae. The representation by ferns and their allies is also poor in comparison to regular substrates at comparable levels of rainfall.

[8]Mamose is the administrative region in northern PNG consisting of *Ma*dang, *Mo*robe, and the *Se*pik provinces. The name is an acronym formed by the first two letters of the provinces, and is also rendered as 'Momase', by the same procedure. Although 'Mamose' is universally understood within PNG, its use is virtually unknown outside the country. There is a certain utility in its usage, because the word refers by coincidence to a part of PNG defined by tectonic and biotic similarities, and thus represents a discrete evolutionary environment.



FIG. 17. Fire succession in the former burn area shown in figure 6. After 4 years, the regrowth consists mainly of *Macaranga bifoveata* (shrubs in photo) and *Machaerina glomerata*. Other colonizers are *Trema cannabina* and *Commersonia bartramia*.

In addition to the impoverished groups, floristic depauperation is further evidenced by the absence of several families which should be present in lowland environments of northern PNG. The families which were not seen included Commelinaceae (notably *Amischotolype* and *Pollia*), Cycadaceae, Dichapetalaceae, Hernandiaceae, Opiliaceae, Ruscaceae (*Dracaena angustifolia* Roxb.), and Tetramelaceae (*Octomeles sumatrana* Miq.). In contrast, Euphorbiaceae, Myrtaceae, and Rubiaceae (except for *Ophiorrhiza* and *Mussaenda*) are exceptionally common. Other families represented by large numbers of individuals are Burseraceae, Clusiaceae, Cyperaceae, Meliaceae, Myristicaceae, Myrsinaceae, and Pandanaceae. However there is an obvious general reduction in floristic diversity, as evidenced by the low species counts relative to other New Guinea environments. The PABITRA transect investigations are currently providing quantitative data for defining these patterns (Sengo in prep.).

One direct consequence of low alpha diversity in KWMA habitats is the disproportionate presence of a small group of plants. Certain taxa are nearly everywhere in the lowland ultrabasic forest. Among understory shrubs and subshrubs, these 'weedy' elements include *Casearia* aff. *erythrocarpa* (sp. ?nov.), *Conandrium polyanthum*, *Fittingia tubiflora*, *Geniostoma rupestre*, *Ixora* sp. (sp. A on checklist), and *Syzygium trivene* sens. str. The understory fern *Lindsaea obtusa* is the most ubiquitous pteridophyte. *Anisoptera thurifera* ssp. *polyandra*, *Hopea glabrifolia*, *Myristica chrysophylla*, *Syzygium furfuraceum*, and *Tristaniopsis macrosperma* are similarly abundant in tall-growth canopy. *Gymnostoma papuana* (exposed ridges and riverbanks) and *Stenocarpus moorei* (streambanks and landslips) often form locally monodominant stands in repetitively disturbed habitats. The subcanopy and middle layers in hill forest below 500 m are dominated particularly by *Brackenridgea forbesii*, *Canarium* spp., *Garcinia* spp., *Gordonia papuana*, *Gymnacranthera farquhariana* var. *zippeliana*, *Haplolobus floribundus*, *Polyosma* cf. *forbesii*, and *Syzygium effusum* sens. lat.

The KWMA lowland vegetation is thus characterized by a limited number of very common species. The disharmonic nature of the flora is similar to insular environments from more isolated stations within the Pacific, and the prevailing patterns are reversed to some extent only in the coastal and alluvial flats bordering the major waterways. In such locations, some of the missing taxonomic elements reappear, presumably due to a reduction in soil toxicity. Alluvial substrates in the KWMA have acidity values to pH 4, unlike the ultrabasic substrates on ridges (Bein, pers. comm. March 2000). There are thus two general floristic associations within the lowland KWMA: 1) a macrophyllous, liane-rich community characteristic of riverine/swampy environments, and 2) a highly disharmonic ultrabasic flora of contrasting generic composition and with some of the attributes of a montane vegetation.

Although *Alyxia acuminata* sens. lat., *Freycinetia* spp., *Hugonia jenkinsii*,

and *Psychotria olivacea* are moderately common in ultrabasic forest, climbing taxa are generally notable by their absence or rarity. Apocynaceae (Asclepiadoideae), *Calamus*, Convolvulaceae (with the exception of *Erycibe*), *Dichapetalum*, *Flagellaria*, *Gouania*, Lomariopsidaceae, *Mucuna*, *Stenochlaena*, *Tecomanthe*, *Uncaria*, and all Vitaceae, are often absent or rare even from open streamcourses and other edge environments where such taxa are ordinarily prevalent. Understories are also remarkably clear, and physical passage through the forest is decidedly easier than with most lowland communities.

On the current forest mapping system for PNG (Hammermaster & Saunders 1995a, b) the Bowutu ultrabasic vegetation is primarily classified as a small-crowned lowland hill forest (code Hs, ibid.), reflecting the overall stunting of the serpentine canopies. KWMA ultrabasic stands are easily detected in aerial photos because of their depauperate appearance, changing only at the transition to regular substrates, where the canopy develops larger, medium-sized crowns (code Hm, e.g. at the Kui ecotone).

In contrast to ultrabasic communities, the alluvial habitats are primarily seral environments, often *Gymnostoma*-dominant and subject to seasonal flooding. These riverine successional areas are generally restricted to the coastal floodplains where the KWMA's clear-flowing streams emerge onto the lowlands (see Hammermaster & Saunders 1995b: Salamaua SB 55-15 overlay). In other low-lying sections near the coast, like the beachfront opposite Lababia Island, the presence of poorly drained flatland is associated with *Metroxylon*-monodominant swamps (Wsw; ibid.). The coastline vegetation also includes scattered seagrass shallows (*Enhalus acoroides*), *Bruguiera-Rhizophora* mangroves, and tidal estuarine forest (Fig. 18), but the areas encompassed by such communities are below the resolution of existing vegetation maps.

DESCRIPTIONS OF NEW SPECIES

RUBIACEAE

Psychotria bulilimontis Takeuchi, sp. nov. (**Figs. 19–21**). TYPE: PAPUA NEW GUINEA. MOROBE PROVINCE: Kamiali Wildlife Management Area, lower slopes of Bulili Mt, multistoried ultrabasic forest, 07° 18.5' S, 147° 07.5' E, 20 m, 6 Oct 2002 (fl, fr), *W. Takeuchi & D. Ama 16428* (HOLOTYPE: LAE!; ISOTYPES: A, BISH, BO, BRIT, CANB, K, L, MO, NSW, US).

Species haec ab aliis congeneribus papuanen inflorescentiis lateralibus fructibus globosisque rhachidi inflorescentiarum teretibus statim distinguitur.

Understory shrub 3–4 m in height, erect, often polelike, sparingly or moderately branched, outer bark thin, dark gray, smooth. **Branchlets** terete, slightly compressed at the top, subapical diam. 2–3(–4) mm, spreading, weak, surfaces green in the leaf-bearing intervals, furfuraceous at the stipular scars, otherwise glabrous, internodes (1–)2–6 cm long. **Leaves** diverging in one plane, glabrous; blades fleshy or subcoriaceous, without domatia or cystoliths, adaxially dark



FIG. 18. *Bruguiera-Rhizophora* mangrove forest at Hessen Bay, KWMA.



FIG. 19. *Psychotria bulilimontis* var. *bulilimontis* in the ultrabasic forest on Bulili Ridge. White arrow: stem base of the type individual.



FIG. 20. *Psychotria bulilimontis* var. *bulilimontis*. The type gathering (*W. Takeuchi & D. Ama 16428*).



FIG. 21. *Psychotria bulilimontis* var. *bulilimontis*. Closer view of the fruit and cymules (*W. Takeuchi & D. Ama 16428*).

green, abaxially mid-green, bifacially olivaceous after drying, linear-elliptic, (7–)12–21 by (1.5–)3.5–6.5 cm, apex gradually acuminate, margins entire, base cuneate, equal; venation pinnate, secondaries 7–12 pairs, (7–)10–22 mm apart, at the lamina center diverging 55–70° from the midrib, arcuate, brochidodromous, tertiary nervation areolate, all venation plane or weakly raised on upper surfaces, prominulous beneath; petiole 8–20 by 1.0–2.0 mm, adaxially channelled or flattened, rounded beneath; stipules valvate, linear-acuminate, to 15 by 4 mm, brownish-green, caducous, adaxially furfuraceous at the base, otherwise glabrous, apex bifid, the arms 3–4 mm long, filiform. **Inflorescence** axillary from the subapical and lower nodes, glabrous, lax, paniculiform, ultimately cymose, the primary branches opposed or 3-verticillate, all axes spreading, light green, delicate (0.5–1.0 mm wide); peduncle (10–)50–85 mm long, primary branches to 25 mm long; peduncular bracts caducous; rachis bracts persisting at the branching points, acuminate, 1–3 mm long; floral bracts triangular, minute. **Flowers** (measurements from spirit-preserved material) tetramerous, glabrous on exterior surfaces, 5.0 mm long, sessile; calyx infundibular, 2.7 by 1.8 mm, limb dentate, teeth ca. 0.2 mm long, erect at anthesis; corolla sympetalous, valvate, white, tube 2 mm long, pilose in a 1 mm wide band at the mouth, lobes ovate, 2.0–2.5 by 1.8 mm, apex acute; stamens alternipetalous, erect, glabrous, anthers exserted, oblongoid, ca. 0.8 mm long, basifixed, introrse, filaments very short, attached at the sinus; gynoecium glabrous, ovary globular, recessed at the summit, style included, ca. 0.6–0.7 mm long, stigma lobes ca. 0.5 mm long, coherent. ***Fruits*** shiny orange-red when ripe, juicy, subglobose, 5 mm diam. *in vivo*, crowned by the calycine residue; pyrenes 2, pale yellow-brown, 2–3-ridged on the back, inside farinaceous, no ruminations.

Distribution and ecology.—*Psychotria bulilimontis* is known only from lowland environments within the Kamiali Wildlife Management Area. The nominate variety is restricted to the ultrabasics.

Etymology.—The epithet commemorates the type locality.

PARATYPE: **PAPUA NEW GUINEA. Morobe Province:** Kamiali Wildlife Management Area, lower slopes of Bulili Mt, multistoried ultrabasic forest, 07° 18.5' S, 147° 07.5' E, 20 m, 25 Aug 2002 (fl, fr), *W. Takeuchi, D. Ama, B. Siga, & Nathan 16416* (A, L, LAE!).

Axilliflorous *Psychotria* are rare in New Guinea. Only *P. axilliflora* Merr. & Perry and *P. dipteropoda* Laut. & K. Sch. are known to flower from subapical nodes. The new species is easily distinguished from its axilliflorous congeners by the globose fruits (fusiform and compressed in *P. axilliflora*) and by the delicate, terete axes of the inflorescence (conspicuously flattened and broad in *P. dipteropoda*).

Psychotria bulilimontis var. **aestuarii** Takeuchi, var. nov. (**Figs. 22–23**). TYPE: PAPUA NEW GUINEA. MOROBE PROVINCE: Kamiali Wildlife Management Area, banks of the Saia River near Hessen Bay, alluvial-estuarine forest, 07° 21.6' S, 147° 07.3' E,

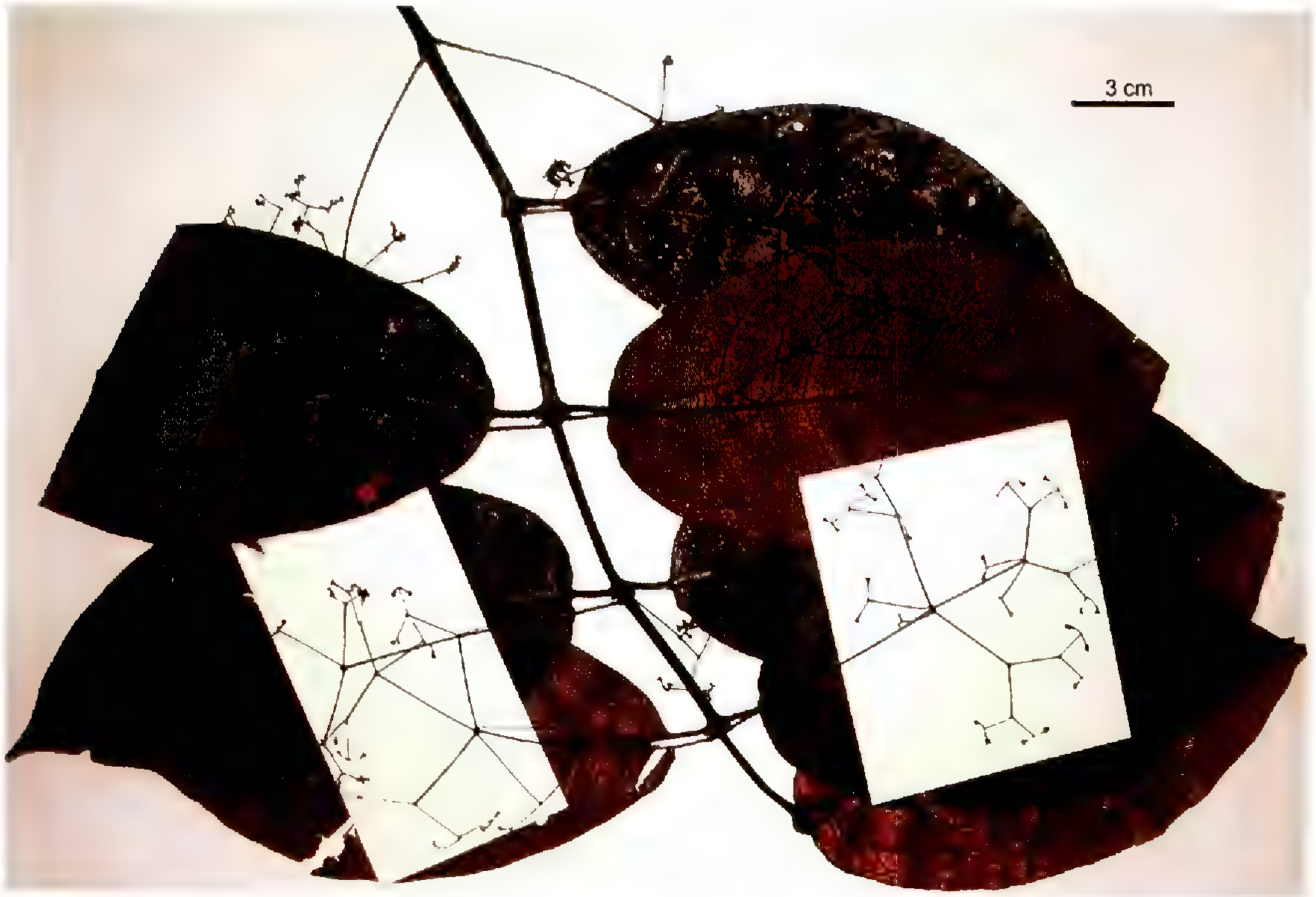


FIG. 22. *Psychotria bulilimontis* var. *aestuarii*. An unmounted duplicate from the type gathering. The delicate, umbelliform inflorescence is characteristic (*W. Takeuchi, B. Siga, & A. Towati 14993*).



FIG. 23. Hessen Bay. Estuarine forest habitat of the type population for *Psychotria bulilimontis* var. *aestuari*.

5–10 m, 15 Jan 2001 (fl), *W. Takeuchi, B. Siga, & A. Towati 14993* (HOLOTYPE: LAE!; ISOTYPES: A, BISH, BO, CANB, K, L, MO, US).

Ab var. *bulilimonti* laminis latioribus ad bases rotundatis vel cordatis, indumento denso denique inflorescentiis umbelliformibus praeclare distinguitur.

Understory shrub 1–2(–4) m in height, erect, sparingly or moderately branched. **Branchlets** obliquely ascending, weakly compressed near the summit, terete below, subapical diam. 2–4 mm, hirtellous, hairs persisting, internodes (2–)4–7(–11) cm long. **Leaves** distichous, spreading; lamina usually fleshy, adaxially dark dull green, abaxially pale green or brownish-green, discolorous after drying, turning black or fuscous above and rufous-brown beneath, upper surfaces glabrous, marked by linear cystoliths or not, lower surfaces hirtellous, hairs orange- or reddish-brown, densest on midribs and veins, domatia absent; blades variable, narrowly to broadly elliptic, ovate, or obovate, (9–)13–23 by (3–)6–11 cm, apex acuminate, margins entire, base subcordate, rounded, (or cuneate); venation pinnate, secondaries 10–12 pairs, (7–)15–20(–28) mm apart, at the lamina center diverging (35–)50–70° from the midrib, arcuate, more or less brochidodromous but reticulating freely beyond the commissural loops, tertiary nervation conspicuously and coarsely areolate, all venation plane or impressed on upper surfaces, prominulous beneath; petiole 5–20 by 1.5–2.0 mm, adaxially channelled or flattened, rounded beneath, indument like the branchlets; stipules valvate, caducous, lanceolate-ovate, to 15 by 5 mm, apex bifurcately divided into 3–4 mm long filiform caudae, exterior surfaces coarsely hairy, inside furfuraceous-barbate along the base, otherwise glabrous. **Inflorescence** axillary from the subapical and lower nodes, umbelliform or paniculiform, the ramifications verticillately branched for 1–3 orders, ultimately cymose, all axes spreading, lax, hirtellous, delicate (0.5–1 mm wide), dull light green; peduncle (10–)35–95 mm long, primary rays to 31 mm long, secondary rays to 16 mm long; peduncular bracts caducous, linear-acuminate, to 3.0 by 0.5 mm; rachis bracts subpersisting at the branching points, acuminate, ca. 1 mm long; bracteoles triangular, ca. 0.5 mm. **Flowers** (measurements from spirit-preserved material) tetramerous, 5.0 mm long, sessile; calyx tubular, 2.0 by 1.5 mm, puberulent, limb dentate, teeth reflexed at anthesis; corolla sympetalous, valvate, white, outer surfaces glabrous, tube 1–2 mm long, mouth pilose, lobes oblong, 2.6–2.7 by 1.2–1.3 mm, apex obtuse or acute; stamens alternipetalous, erect, glabrous, anthers oblongoid, ca. 0.5 mm long, basifixed, introrse, filaments very short, attached at the sinus; gynoecium glabrous, ovary recessed at the summit, style exserted, ca. 4.5 mm long, stigma conspicuously bilobed. **Fruits** immature, globose.

Distribution and ecology.—Known only from coastal forests in the Kamiali Wildlife Management Area.

Etymology.—The varietal name reflects the estuarine forest habitat of the type population.

PARATYPES: **PAPUA NEW GUINEA. Morobe Province:** Kamiali Wildlife Management Area, banks of the Saia River near Hessen Bay, alluvial-estuarine forest, 07° 21.6' S 147° 07.3' E, 5–10 m, 15 Jan 2001 (fl), *W. Takeuchi, B. Siga, & A. Towati 14990* (A, L, LAE!); ditto, *W. Takeuchi, B. Siga, & A. Towati 14995* (A, BO, K, L, LAE!, MO); ditto, *W. Takeuchi, B. Siga, & A. Towati 15002* (A, BISH, BO, CANB, K, L, LAE!, MO, US).

Variety *aestuarii* is clearly referable to *Psychotria bulilimontis*. The lax and delicate inflorescence from lowermost axils is very distinctive and characteristic of the species. However unlike the nominate variety, the alluvial plants are very hairy shrubs with broad leaves and a pronounced tendency for umbelliform branching on the inflorescence. In contrast, the ultrabasic populations (var. *bulilimontis*) are essentially glabrous, with narrow leaves gradually tapered at both ends, and a more paniculiform inflorescence. Both varieties have heterostylous flowers.

SALICACEAE

Trichadenia sasae Takeuchi, sp. nov. (**Figs. 24–27**). TYPE: PAPUA NEW GUINEA. MOROBE PROVINCE: Kamiali Wildlife Management Area, base of Bulili Ridge at Kulindi, ultrabasic forest, 07° 18' S, 147° 08' E, 0–5 m, 4 Feb 2003 (fr), *W. Takeuchi, D. Ama & B. Siga 16561* (HOLOTYPE: LAE!; ISOTYPES: A, BO, CANB, K, L).

Species haec ab aliis congeneribus laminis cordatis usque ad 31.5 cm longisque 27.0 cm latis, dense velutinis fructibus magnis 4 cm diametris perfacile recognoscitur.

Canopy tree 25 m tall, unbuttressed, highly branched, outer bark gray, thick, rough-textured, slash orange-brown, without exudate, sapwood pale yellow. **Branchlets** terete, 12–15 mm in diam. below the leaf spray; indument subpersisting, orange-brown velutinous, usually with a monolayer of erect septate hairs, sometimes also with an underlayer of crispate hairs; periderm dark gray, longitudinally fissured; abscission scars conspicuous, patelliform, 4–10 by 7–12 mm. **Leaves** spirally congested in apical tufts, spreading; blades coriaceous, bichromatic *in vivo*, adaxially dark green, abaxially yellowish-green, olivaceous *in sicco*, the mature laminae manifestly cordate, 22.5–31.5 by 20.5–27.0 cm, apex obtuse, (emarginate, or mucronate), margins entire or irregularly repand, depth of basal sinus (2.0–)2.5–4.0(–5.5) cm; upper surfaces pilosulous on veins, glabrescent between, lower surfaces velutinous; venation plinerval-palmatiform at the petiole, pinnate above the base, craspedromous, secondaries 5–8, (15–)30–70(–85) mm apart, at the lamina center diverging (45–)50–55(–60)° from the midrib, straight (or arcuate), sometimes sparingly anastomosing before the margin, tertiary nerves scalariform, reticulum conspicuously and bifacially areolate, adaxially impressed, all venation prominent below; petioles strictly cylindrical, 5–10 cm by 2.5–4.0 mm on apical leaves, progressively longer on lower leaves (to 18 cm by 5.0 mm), swollen at both ends, geniculate, indument like the branchlets; stipules caducous, subulate, 7–12 mm long, densely hairy. **Flowers** unknown. **Infructescence** solitary from axils of attached leaves, densely velutinous; peduncle ca. 10 mm long, rachis terete, 10–20 by 3–7 mm, unbranched;



FIG. 24. *Trichadenia sasae*. Crown form of the type individual (*W. Takeuchi, D. Ama & B. Siga 16561*).

bracts linear-acuminate, 1.5–2.0 mm long, caducous; pedicels 1.5–3.0 by 5–6 mm, articulated at the rachis. **Fruits** indehiscent, pendulous, globose, 40–43 by 38–43 mm, bilobed or obscurely trigonous, (38–47 by 46–55 mm), epicarp pale grayish-brown through all stages of maturation, lenticellate, laxly hirtellous (glabrous to naked eye), surface scrape bright green, no exudate, pericarp thin (ca. 1 mm), crustaceous, entire *in vivo*, usually collapsing and coarsely rugose after drying; mesocarp at first straw-pale brown, later yellow and baccate, ripe pulp fleshy, no odor; seeds 1–3, endosperm copious, white, turning pink after sectioning.

Distribution and ecology.—*Trichadenia sasae* is known with certainty only from the closed-canopy forest bordering Nasau Bay. All confirmed sightings have occurred on the ultrabasics.

Etymology.—The new species is named after colleague Sasa Zibe-Kokino, a professional forester and prominent conservation advocate, currently serving as the Member of Parliament for Huon electorate.

PARATYPE: **PAPUA NEW GUINEA. Morobe Province:** Kamiali Wildlife Management Area, base of Bulili Ridge at Kulindi Science Center, ultrabasic forest, 07° 18' S, 147° 08' E, 0–5 m, 25 Nov 2001 (fr), *W. Takeuchi, D. Ama & B. Siga 15589* (A, BO, CANB, L, LAE!, MO, US).

The genus *Trichadenia* was previously represented in the Malesian region only by the widely distributed *T. philippinensis* Merr. A second species (*T. zeylanica*



FIG. 25. As for figure 24, looking into the crown from below.



FIG. 26. *Trichadenia sasae*. Detached branchlets from the type gathering.



FIG. 27. *Trichadenia sasae*. Parataxonomist Demas Ama holds a fruiting branchlet against the bole.

Thwait.) is endemic to Ceylon (Sleumer 1954). The new *Trichadenia* is easily recognized by its large cordate leaves, dense indument, and large fruits.

The field appearance of *T. sasae* is similar to the *Sterculia ampla-macrophylla* complex and is thus almost impossible to identify from a distance. The type tree was for several years misidentified as a *Sterculia* due to the gross similarities in habit. There are apparently several individuals of this species along the Bulili coast but few have been seen in fertile condition. The species is not common within the KWMA.

NOTES ON OTHER TAXA

CONVOLVULACEAE

Erycibe spp.—*Erycibe* is generally an uncommon genus in PNG. When last treated by Hoogland (1953a, b) and Oostroom (1953, 1955), most taxa were known from only a small number of specimens. The current species concepts are ill-defined, in part due to the former scarcity of materials for study and by what appears to have been an excessive splitting of the variation. As is generally true of canopy lianes with brightly colored fruits and inconspicuous flowers, most of the modern gatherings consist of fruiting material which are less useful than flowering ones. The genus is greatly in need of revision.

In contrast to most PNG localities, *Erycibe* is well represented within KWMA alluvial habitats, but all existing specimens are in fruit and cannot be keyed out. While many Morobe collections are apparently conspecific with the KWMA species, none of the sheets has been reliably identified and the assigned names seem to have been taken up by successive collectors in uncritical fashion. The KWMA *Erycibe* are neither rare or new, but the difficulties involved in their identification are symptomatic of a greater problem with the genus as a whole.

CYPERACEAE

Cladium mariscus (L.) Pohl sens. lat.—A cosmopolitan species, but rare in New Guinea and not previously recorded for PNG (Hay 1984). LAE has no recent accessions from New Guinea other than the survey voucher.

FABACEAE

Maniltoa sp. (Verdcourt sp. E)—The only *Maniltoa* recorded in the ultrabasic lowlands is apparently an undescribed taxon closely related to *Maniltoa schefferi* K. Sch. & Hollrung. On Verdcourt's (1979) alphabet list of novelties, the KWMA plants are referable to species E, distinguished by sessile ovaries and fruits. *Maniltoa* E is very common within the hill forest and consistently maintains its separate character. There are no transitional forms to *M. schefferi*. The KWMA *Maniltoa* is apparently restricted to the serpentine zone and is arguably best regarded as a subspecies. In other characters, species E is so similar to *M. schefferi* that it would be inappropriate to establish a new species on just one differentiating trait.

LECYTHIDACEAE

Barringtonia spp.—At least five species of *Barringtonia* have been documented on the ultrabasics (*B. apiculata*, *B. asiatica*, *B. lumina*, *B. pinifolia*, and *B. racemosa*; see Jebb 1991). KWMA *Barringtonia* are partitioned by habitat into two groups, with *B. asiatica* and *B. racemosa* occurring mainly along the coast, and the remaining species ranging into the upper drainages and interior hill forest. *Barringtonia pinifolia* is particularly common within alluvial communities near the base of the main range. In comparison, the distinctive *B. lumina* was seen only a few times along the Saia River and is apparently rare.

Barringtonia is widely employed as a fish poison in lowland New Guinea (ibid.; Payens 1967; Peekel 1984) but Kamiali villagers apparently use only *Derris trifoliata* ('rop dynamit') for fishing. This situation is certainly not due to a lack of availability, since *Barringtonia* spp. are present in large, easily-accessed populations around the main village and fishing camps. Some respondents claim that *Derris* is more effective on the reefs than *Barringtonia*, but this assessment is not universal. Although the use of plant poisons for fishing is a well-established practice in Kamiali society, it has been traditionally discouraged except in special circumstances (Martin 1998, 1999). The growing frequency of reef bombing and *Derris* 'dynamiting', are manifestations of the changes occurring within Kela society, and of the declining influence of customary observances.

MALVACEAE

Sterculia sp. nov., aff. **ampla-macrophylla** group

Sterculia sp. ?nov., aff. **shillinglawii** F.v.M.

The KWMA has two possible novelties in *Sterculia*.

Tantra (1976: 75–6) regarded *Jacobs 9639* from the Buso-Kui foothills as a new species in the *ampla-macrophylla-morobeensis* group, but formal description was deferred pending acquisition of more complete material. No new collections have been made since the initial gathering in 1973. A series of numbers from the current survey also cannot be identified with Tantra's conspectus (ibid.), and may represent another undescribed species.

MELASTOMATACEAE

Astronidium morobiense Maxw. (**Figs. 28–29**).—The species was previously known only from mossy fagaceous forest between 1350–1800 m near Wagau (Maxwell & Veldkamp 1990). However recent determinations (ex S.S. Renner, pers. comm. March 2003) indicate that the species is distributed southwards along the Morobe coast as far as Natter Bay, with occurrences in both ultrabasic and non-serpentine habitats.

In marked contrast to the environment specified in its protologue, the KWMA populations of *A. morobiense* are found primarily at low elevations. On Bulili Ridge, the species is even found at sealevel, immediately behind the highwater line and in forest occasionally subject to saltwater damage. Between



FIG. 28. *Astronidium morobiense*, in the sealevel ultrabasic forest near Kulindi, KWMA.



FIG. 29. As for figure 28, showing the inflorescence (*W. Takeuchi & D. Ama 16223*).

Lokanu-Tambu Bay and Kui village (Fig. 5), the only remaining hill forest is on the headlands bordering Sachsen and Hessen Bays (e.g. Cape Dinga and Cape Roon). The communities in or near these areas often have taxa at their lowest elevations of record (e.g. *Astronidium morobiense*, *Bhesa archboldiana*, *Gnetum costatum*, *Hunga papuana*, *Lophopetalum torricellense*, *Mackinlaya schlechteri*, *Nastus schlechteri*, *Ormosia calavensis*, *Paphia*, *Psychotria archboldii*, and *Syzygium richardsonianum*).

MYRSINACEAE

Fittingia urceolata Mez and **F. tubiflora** Mez (**Figs. 30–31**).—These obviously related species are sympatric and vegetatively indistinguishable. *Fittingia urceolata* is noticeably more frequent on the ultrabasic substrates than its congener, but the two often occur side by side outside the serpentine (e.g. the foothills at Paiewa). The only distinction between the species is in the color of the drupes (red for *F. tubiflora* and white for *F. urceolata*; Sleumer 1988).

Sleumer (ibid.) suggested the apparent difference in fruit color might not be an adequate basis for discrimination between the species, although he accepted the separation in his revision. Field observations from the recent surveys show that the color contrasts are indeed consistent and effective discriminators. In *F. tubiflora* the red color is evident even in the ovary of the anthetic flower (label data for *14429*) and is preserved as the fruit develops through a marble-like phase and eventually into the spongy-textured drupe from which the generic name is derived. Whether or not a species pair should be upheld on the basis of a single contrasting character is a matter of subjective judgment, but the color distinction is certainly not some transient feature related to fruit maturation—i.e. white fruits do not ripen into red fruits or vice versa. It may be more appropriate to relegate the taxa to varietal rank, but in any event, there is a readily detectable difference in living material.[9]

MYRTACEAE

Syzygium trivene (Ridley) Merr. & Perry and **S. lorentzianum** Laut.—*Syzygium lorentzianum* was known to Hartley and Perry (1973) only from the type. The species is supposedly distinguished from *S. trivene* by slight differences in leaf form and by the longer flower buds (ibid.: 177).

Within the KWMA, *S. trivene* sens. str. is one of the most common subarborescent taxa of riverine understories and interior forest. From examination of the survey's many numbers, it is evident that the characters separating this species from *S. lorentzianum* are part of an intergrading series of variation. In general, *S. lorentzianum* is the name of a robust form growing in exposed areas (e.g. along streambanks) while *S. trivene* is the spare variant of closed

[9]Most of the survey duplicates were distributed indicating a synonymy between the names (i.e. as *F. tubiflora* = *F. urceolata*.



FIG. 30. *Fittingia urceolata*. The pericarp is hyaline green in the immature fruit, but turns opaquely white with ripening (*W. Takeuchi, A. Towati, B. Siga, & M. Kavua 16172*).



FIG. 31. *Fittingia tubiflora*. In contrast to the congener, fruits are red from the start of their development (there is no green phase). The initially hard pericarp becomes spongy-textured and somewhat juicy when ripe (*W. Takeuchi, B. Siga, & A. Towati 14991*).

forest. The distinctions appear environmentally determined and thus undeserving of formal recognition. *Syzygium trivene* should be regarded as a synonym of *S. lorentzianum*, since the latter has the older epithet.

POACEAE

Nastus schlechteri (Pilger) Holtt., or aff.—The condensed panicles and aristate basal glumes are distinctive. Apparently known only from the type (*Schlechter 19720*), which was not seen by Holttum (1967) and presumably lost at Berlin.

The KWMA collections are from atypically low elevations for the genus, having been obtained from ca. 100 m, but the vouchers otherwise conform to Holttum's species description and the key (ibid.).

RUBIACEAE

Psychotria archboldii Sohmer, **P. mayana** Takeuchi, **P. melanocarpa** Merr. & Perry—Indument and fruit color are the principal means for separating these taxa. *Psychotria archboldii* is entirely glabrous on all parts, while *P. mayana* and *P. melanocarpa* have stelliform hairs. Although *P. archboldii* has red fruits, the drupes are white in *P. mayana* and black in *P. melanocarpa*. The three species are apparently geographically separated. Only *P. archboldii* var. *archboldii* has an appreciable distribution, occurring from Morobe to Milne Bay and offshore islands (var. *multinervia* is known by a single collection from Gulf Province), while *P. mayana* and *P. melanocarpa* have been found only in Madang and Western Provinces, respectively. Apart from these distinctions, the plants are obviously related and can be plausibly regarded either as sibling species, or as geographically separate subspecies. Herbarium specimens from the *archboldii-mayana-melanocarpa* complex are visually striking, with bright orange-brown or rufous leaves. The large fruits are invariably jet black on exsiccatae, irrespective of the coloration *in vivo*.

In *P. archboldii* as a whole, there is considerable doubt about the fruit color, a character widely employed by Sohmer (1988) as a basis for species separations among the Papuasian congeners. Although variety *archboldii* is recorded as having red fruits, the KWMA populations of this variety were collected with white drupes. The fruits of *P. archboldii* var. *multinervia* are also supposedly white, according to the label for the only existing specimen (though the variety was formally described as having red fruits).

The discrepancies could be explained if *P. archboldii* has distinct color phases with the fruit maturing from white to red, or less plausibly from red to white. However such color changes have never been substantiated for any Papuasian *Psychotria*. If fruit color has no significance in this species complex, the present separations should be dismantled and recognition given only to geographic subspecies or races.

Psychotria croftiana Sohmer—*Psychotria croftiana* is a large-leaved species pre-

viously known from three fruiting collections on the Huon coast (Sohmer 1988). It is a common and conspicuous shrub in the ultrabasic forest but also occurs on the nonserpentine substrates southeast of Buso. The distinctively papillate-hairy flowers were unknown until the recent surveys. A supplementary description of the flowering plant can be provided from the new material:

Inflorescence paniculate, pyramidal, exceeding the leaves at anthesis, to 37 by 29 cm, all axes glabrous; peduncle 7–13 cm long, first order branches 3–4-verticillate, to 17 cm long; rachis bracts acuminate, 2–6 mm long, abruptly subulate at the apex, subpersisting, abaxially glabrous, adaxially furfuraceous at the base; floral bracts inconspicuous, linear or linear-acuminate, ca. 0.5 mm long; pedicels 1–2 mm long; cymes lax. **Flowers** (measurements from rehydrated material) 5(–6)-merous, 2.5 by 3.5 mm at anthesis; calyx infundibular (shallowly cupular when dry), parted about halfway to the base, lobes triangular, equal, ca. 0.5 mm long; corolla white, obovoid in bud, tube 1.7 by 1.8 mm, glabrous on all exterior surfaces, mouth not clearly barbate, lobes adaxially papillate-hairy, acute, 1.0 by 1.2 mm, reflexed at maturity; stamens alternipetalous, anthers erect, oblongoid, 0.6–0.7 mm long, filaments short, inserted about halfway down the tube; gynoecium glabrous, ovary dome-shaped, recessed at the top, style 0.7 mm long, stigma 0.3 mm long, slightly expanded, columnar, 5–6-sulcate, not or only weakly exserted.

Specimens examined: **PAPUA NEW GUINEA. Morobe Province:** Kamiali Wildlife Management Area, lower slopes of Bulili Mt, ultrabasic forest, 07° 18.5' S, 147° 07.5' E, 40 m, 6 Oct 2002 (fl), *W. Takeuchi & D. Ama 16430B* (A, BO, CANB, K, L, LAE!, MO, US); base of Lababia Ridge, ultrabasic forest, 07° 16' S, 147° 06' E, 75 m, Oct 2002 (fl), *W. Takeuchi & D. Ama 16578* (A, LAE!).

Psychotria waiuensis Sohmer—*Psychotria kamialii* Takeuchi, Edinburgh J. Bot. 58:159–161. 2001. TYPE: PAPUA NEW GUINEA. MOROBE PROVINCE: Kamiali Wildlife Management Area, 1.5 km W of Lababia Village, 07° 17' S, 147° 06' E, 5–10 m, 14 Nov 1999, *W. Takeuchi & J. Sengo 14310* (HOLOTYPE: LAE; ISOTYPE: K).

Current fieldwork indicates that the recently described *Psychotria kamialii* must unfortunately be regarded as a synonym of *P. waiuensis*. As the most obvious point of distinction from its closest congeners, the monocaulous habit of *P. kamialii* was the principal character used to establish that species. Because of an emphasis on architectural form, the equivalence to *P. waiuensis* was overlooked. There are several points which can be made in relation to the synonymy.

First, it is very unlikely that *P. waiuensis* is a 10 feet (3 m) tall shrub as indicated in the diagnosis. *Psychotria waiuensis* is not rare, and every plant seen during the recent surveys were monocaulous dwarfs occurring as helophytes in shallow mud or standing water. In this respect the plant is similar to the higher elevation forms of *P. ramadecumbens* Sohmer. The type gathering for *P. kamialii* for example, was a colony sample from sago swamp, taken from separate 0.5 m individuals. The KWMA populations have never been seen growing on firm ground as medium-sized branching shrubs. Although *P. waiuensis* is described

as 'about 3 m' (Sohmer 1988) this figure is probably a label error. It is more plausible that the first collections at Waiu Bay (Braunschweig Harbor on most maps) were also monocaulous subshrubs, as suggested by the fact that the earlier sheets show no indication of branching. Most of the bayfront at Waiu is a coastal swamp similar to the type locality for *P. kamialii*, so a general stunting of woody plants would also be expected at the earlier collection site. Because the actual habit of this swamp species was not appreciated, Sohmer's (1988) key will go astray at fork 107, where there is a couplet separation between monocaulous and branching shrubs. *Psychotria waiuensis* will actually key out to *P. inconspicua* Merr. & Perry, as happened during the initial evaluation of *P. kamialii*.

As presently known, *P. waiuensis* occurs only between Kamiali and Waiu, an area consisting mainly of ultrabasics. However future collectors will probably find this species further south along the coastline, since the swampy forests which the plant inhabits are not restricted to serpentine. Judging from its current habitats, *P. waiuensis* may be present in the coastal wetlands near the Morobe-Waria Rivers, where extensive areas of comparable environment can be found.

Coastal swamps are such disagreeable places that it is easy to understand why only one collection existed of *P. waiuensis* prior to the recent surveys, even though the species is moderately common. The presence of saltwater crocodiles (*Crocodilus porosus*) and swarms of mosquitos are disincentives to loitering in these shoreline areas. The most promising strategy for collectors is to work the ecotone along the margins of the swamps, rather than their interior parts. If the putative differences between *P. waiuensis* and *P. kamialii* are derived from substrate conditions, different growth forms should be found at the contact between swamp and dry land.

SALICACEAE

Homalium d'entrecasteauxense Craven—Formerly known only by the type collection from Normanby Island (Craven 1979). In the survey vouchers, stamens are consistently arranged in 3-membered fascicles. Branchlets are puberulent.

Steenis (1982) expressed doubt over the number of new species recognized by Craven (1979), and of their distinction from the variable *H. foetidum* (Roxb.) Benth. The taxonomic issues are still unresolved because of the limited number of specimens available for study (7 out of the 10 Papuasian species are known only from the types). Multiple collections showing the variation within individual populations are much needed.

The new gatherings from the KWMA suggest that staminal number is an effective criterion for splitting *H. d'entrecasteauxense* from the *foetidum* complex. This separation is corroborated in the field by differences in stature and habit. The Kamiali specimens of *H. d'entrecasteauxense* were taken from frail,

4 m tall understory shrubs, but *H. foetidum* is ordinarily a robust timber-sized tree. The survey specimens also confirm the differences in indument between *H. d'entrecasteauxense* and *H. maneauense* Craven (see modified key in Steenis 1982: 564).

THELYPTERIDACEAE

Plesioneuron croftii Holtt.—Formerly known in the literature only by the type collection from Natter Bay, but now also represented by newer material from the Waria basin and Buso.

Plesioneuron croftii is similar to *P. dryas* Holtt., differing primarily in the color of the aerophores (dark in *P. dryas* and pale in *P. croftii*; see Holttum 1981). The recent collections are closest to *P. croftii* but have dark aerophores, and seem to combine characteristics of that species and its congener. Although the position of the sori near costules is of some value in the identification of *P. croftii* (ibid: 399), the distinction is small and inconstant, and probably unworthy of specific rank.

DISCUSSION

Whether or not floristic patterns discerned in the KWMA are of general application to other floras is unknown, especially as the ultrabasic patterns are difficult to separate from those applying to the Papuan Peninsula as a whole. Although the distribution of ultrabasic substrates can be extracted from the geological literature, information on the associated vegetation is sparse and unsubstantiated. There are no checklists or forest descriptions of representative formations anywhere in PNG. The patterns found at Kamiali may be unique to the Bowutu communities, but at least within the KWMA, the lowland serpentine has been sampled to very high intensities, and is presently one of the better known lowland floras in New Guinea. Approximately 1,915 specimens have been compiled from a lowland area of 215 sq km, for a collections density (CD) of 890 collections per 100 sq. km.[10] The current checklist includes 130 families, 412 genera, and ca. 710 morphospecies. Most of the lowland taxa from the Kamiali area have probably been recorded. In view of the general depauperation of serpentine floras, the species counts primarily reflect the sampling saturation achieved by the surveys, rather than any special richness of the serpentine plant life. At Josephstaal for example, an inventory of lowland rainforest below 400 m recorded a total of 139 families, 445 genera, and 730 morphospecies (Takeuchi 2000), an outcome very similar to the Bowutu study. However the

[10]Stevens (1989) notes that the current benchmark of 50–100 collections per 100 sq km does not necessarily represent a well-collected locality. The Bowutu inventory demonstrates that even at much higher sampling intensities, unknown taxa will escape detection. Once an adequate baseline has been established for a specific flora, further progress will be dependent on how additional collections are distributed through space and time, rather than the mere acquisition of more material.

Josephstaal assessment involved only one month of survey work, while the ultrabasic itinerary was much more intensive, consisting of repeated fieldtrips over a period of four years.

The results at Kamiali have been constrained by the surveys' strict and deliberate focus on the lowland zone below 500 m. On Mt Kinabalu, the speciose character of the vegetation has been attributed primarily to the presence of ultrabasic outcrops in the montane elevations (Beaman & Beaman 1990). Species counts in the KWMA are likely to increase considerably when investigations are extended into the higher habitats where most of the diversity in New Guinea environments are probably concentrated. A substantial number of Bowutu taxa have already been typified from NGF collections made at Lake Trist (elev. 1800 m), mainly by Henty in 1966 (*NGF 29004–29138*). Many of these montane serpentine records are still known only from the original collection, a situation similar to the Kinabalu ultrabasics (ibid.). Existing evidence suggests that a fair number of species remain undiscovered. Unlike Mt Kinabalu however, the KWMA lowland ultrabasics have relatively few species, which for the most part are already well-represented in collections from Buso, Kamiali, and Kui. The recent high-intensity surveys have started to reveal the presence of rarer endemics such as *Discocalyx kaoyae*, *Paphia megaphylla*, and *Trichadenia sasae*. *Mammea papyracea* (*NGF 39414*), *Pouteria gillisonii* Vink (*NGF 25627*), and *P. pullenii* Vink (*NGF 25625*), known only from their types, are also probably rare plants from the ultrabasics (cf. Stevens 1995; Vink 2002).

Despite the extensive work done by earlier botanists at Buso and Kui, the lowland ultrabasics are still a fruitful venue for new material. Even supposedly well-collected localities can be a source of floristic discovery when exploration routes are slightly altered from the previously-used tracks (Stevens 1989). The recent discoveries are a case in point. Papuasian collectors often retrace the field itineraries of previous investigators due to the convenience of following well-used trails. Yet because plant distributions are typically very patchy across seemingly homogeneous or comparable habitats (Oatham & Beehler 1998), slight changes in exploration schedules can be immensely productive. In the KWMA, adjacent ridges often have very different compositions and species frequencies even across the same geological substrates (Sengo in prep.).

Some idea of the conspicuous contrasts in plant distributions and frequencies can be seen when comparing the collections from Buso and Kamiali. For example, *Kairothamnus phyllanthoides* and *Plesioneuron croftii* are common at the former locality, but have not yet been recorded from immediately adjacent Kamiali habitats. Conversely, although *Psychotria bulilimontis* and *Timonius* sp. ?nov. are plentiful in the KWMA hill forest, they have yet to be collected at Buso. Distributional peculiarities are further exemplified by plants that are essentially restricted to the ultrabasics, having high frequencies inside

the KWMA, but which are also known from one or two collections on normal substrates elsewhere on the Papuan Peninsula (e.g. *Astronidium morobeense*, *Guioa grandifoliola*, *Hunga papuana*, and *Zanthoxylum novoguineense*).

Patchiness of the plant distributions on ultrabasics occurs over a range of spatial scales. At one end, are the localized differences reported by Oatham and Beehler (1998) at Lakekamu. These may be due to the dynamic fragmentation of the forest caused by disturbances such as storms and changes in streamcourse. On a larger scale, plant distributions can vary markedly along different ridges or rivers, even though there are no obvious habitat factors separating the occurrences (Frodin 1990; Grubb & Stevens 1985; Kalkman & Vink 1970). The different levels of patchiness have obvious implications for floristic exploration. Perfunctory surveys will probably miss many of the most significant plants, particularly those with quirky distributions. These difficulties are compounded by unpredictable phenologies and the resulting element of chance in the results achieved by surveyors.

Within the Bowutu tract, taxa endemic to the ultrabasic belt include *Calophyllum streimannii*,[11] *Discocalyx kaoyae*, *Freycinetia curvata*, *F. kamialiensis*, *F. mediana*, *F. rubripedata*, *Kairothamnus phyllanthoides*, *Myristica filipes*, *Paphia megaphylla*, *Psychotria bulilimontis* var. *bulilimontis*, and *Solanum symonianum*. The percentage of strict endemics in the local flora is small compared to more extreme environments (e.g. the Waigeo ultrabasics in Irian Jaya, where rainfalls are much lower than in the KWMA; cf. Takeuchi 2003b). Humid conditions appear to reduce the intensity of effects from serpentine substrates. An inverse relationship between rainfall and the severity of the serpentine syndrome has been noted for other areas (e.g. Kruckeberg 1985).

An overwhelming majority of the KWMA species occur on both sides of a serpentine contact, although there are apparent differences in relative frequencies when passing across such boundaries. The floristic contrasts are primarily ones of degree rather than quality. With so many lowland areas being altered by anthropogenic development, the natural distributions of many native species will become difficult to determine in the future. This will complicate comparative studies on PNG's ultrabasic ecosystems . Most of the coastal habitats south of Kamiali are now fragmented by logging damage, and the real range of plants comprising the Papuan Peninsular flora is increasingly obscured by forest destruction.

In view of the general connection between serpentine effects and rainfall, the growing incidence of El Niño-associated droughts is likely to result in future floristic change which will amplify existing patterns. As rainfalls are reduced, ultrabasic effects should increase, and floristic distinctions across the substrate contact at Kui will become more acute. This is likely to be accompanied by a

[11]But *C. streimannii* may be present in Western Province (see Stevens 1995)

sharper physiognomic discontinuity at the contact (i.e. a more obvious reduction in tree statures and crown densities across the boundary). Floristic attenuation can be expected to involve mainly the generalist species that lack serpentine-coping mechanisms. Since many of these plants (e.g. *Canarium*) are used by Kamiali villagers, a reduction in forest ethnobotanical values is probable. Future changes in beta-diversity patterns can also be anticipated in the montane parts of the ultrabasic belt. The KWMA's mossy forests above 500 m were severely affected by the recent El Niño episodes of 1997–98 and 2002. Repeated droughts could result in a lifting of the ecotone and an associated degradation of watershed services.

APPENDIX 1. LOWLAND PLANTS RECORDED FROM KAMIALI

Voucher source for occurrence record: LAE = collections from the Lae Herbarium institutional (new) series; NGF = collections from the New Guinea Force series; nv = non visus, specimen not found at LAE but cited in the literature and/or entered in LAE logbooks; sn = sin numéro (without number); SR = sight record; numbers without prefix = W. Takeuchi et al. (usually with D. Ama, B. Siga, and/or A. Towati). Other collectors indicated by name.

The checklist is a compilation of collections (below ca. 500 m) from the ultrabasic zone between Kamiali and Kui. Specimens from the present survey have been determined by WT unless otherwise noted. Determinations to earlier collections are based on annotations from published revisions or from specialist tickets on herbarium sheets.

FERNS AND FERN ALLIES

ADIANTACEAE

Acrostichum speciosum Willd.; 14896
Adiantum hollandiae v.A.v.R.; 15228
Pityrogramma calomelanos (L.) Link; 15062
Syngramma borneensis (Hook.) J. Smith; 14468
Syngramma grandis (Copel.) C. Chr.; LAE 52303 (nv); NGF 45222
Taenitis blechnoides (Willd.) Sw.; 14642, 14659; Kog 30; NGF 44261; Palis 27

ASPLENIACEAE

Asplenium laserpitiifolium Lam.; 14722, 14840, 14915, 14917
Asplenium cf. *musifolium* Mett.; 14705
Asplenium nidus L. var. *nidus*; 14702; Unkau 96
Asplenium phyllitidus Don ssp. *malesicum* Holttum; NGF 45123, 45124; Palis 30

ATHYRIACEAE

Callipteris prolifera (Lam.) Bory; 15242
Diplazium cordifolium Bl.; NGF 45175
Diplazium esculentum (Retz.) Sw.; 15251

BLECHNACEAE

Blechnum orientale L.; 14613
Blechnum vittatum Brack.; 14815, ?14973, 15059, 15102
Stenochlaena milnei Underw.; SR, Tabali riverbanks

CYATHEACEAE

Cyathea macgillivrayi (Bak.) Domin; 15036, 15356
Cyathea werneri Ros.; 14881
Cyathea sp., subsection *Sarcopholis*; 15205

DAVALLIACEAE

Davallia heterophylla Sm.; 14615B, 15390; NGF 24493
Davallia parvula Hook. & Grev.; 14391
Davallia pectinata Sm.; 14411, 14538
Davallia repens (L.f.) Kuhn; 15215
Davallia solida (G. Forst.) Sw. var. *solida*; 14358, 14539, 14686, 15225

DENNSTAEDTIACEAE

Hypolepis tenuifolia (Forst. f.) Bernh. ex Presl; 15067

Pteridium aquilinum (L.) Kuhn; 15060

DRYOPTERIDACEAE

Dryopolystichum phaeostigma (Cesati) Copel.; 14554, 14646, 14685, 14878; Manseima 19; Palis 19

GLEICHENIACEAE

Dicranopteris linearis (Burm. f.) Underw. var. *subferruginea* (Hieron.) Nakai; 14609, 15052

GRAMMITIDACEAE

Ctenopteris blechnoides (Grev.) Wagner & Grether; 14776, 14794, 15141, 15172, 15214; Conn et al. 208; NGF 45189; Palis 31

HYMENOPHYLLACEAE

Hymenophyllum sp. (*Mecodium*); 15231

Trichomanes (*Cephalomanes*) *atrovirens* Kunze; 14895, 15183; Akia 17; Gawi 22; Ron 28

Trichomanes (*Selenodesmium*) *obscurum* Bl.; 14674, 15185; Damas 1; Palis 29; Rau 288

Trichomanes sp., *Nesopteris-Selenodesmium* group; 16619

LINDSAEA GROUP

Lindsaea ensifolia Sw. ssp. *agatii* (Brack.) Kramer; 14608, 15336

Lindsaea ensifolia Sw. ssp. *ensifolia*; 15140

Lindsaea ensifolia Sw. x *?L. obtusa* J. Smith; 14880

Lindsaea gueriniana (Gaud.) Desv.; 14326, 14668, 14789, 14842, 15352, 16433; Gawi 24

Lindsaea kingii Copel.; 15226; NGF 39415

Lindsaea obtusa J. Smith; 14319, 14390, 14407, 14649, 14669, 14690, 15174B, 15180, 15440; Gawi 23; NGF 45125

Lindsaea repens (Bory) Thwaites var. *sessilis* (Copel.) Kramer; 15186; NGF 39420

Sphenomeris retusa (Cav.) Maxon; 14996

Tapeinidium longipinnulum (Ces.) C. Chr.; 15196; Gawi 27; NGF 45126, 45127

LYCOPODIACEAE

Huperzia cf. *carinata* (Poiret) Trevisan; 14716, 14932

Huperzia phlegmaria (L.) Rothm.; 14710, 14843, 15211

Huperzia squarrosa (Forst. f.) Trevisan; 14812

Palhinhaea cernua (L.) Vasc. & Franco; 14643, 15051

MARATTIACEAE

Marattia sp., aff. *?megaptera* Copel.; 15155, 15158, 16598

OLEANDRACEAE

Nephrolepis falcata (Cav.) C. Chr.; 14621

Nephrolepis hirsutula (Forst.) Presl; 15232

OPHIOGLOSSACEAE

Ophioglossum pendulum L. f. *pendulum*; 14914; LAE 51690; NGF 45223

PARKERIACEAE

Ceratopteris thalictroides (L.) Brongn.; 15253

POLYPODIACEAE

Drynaria rigidula Bedd.; 14536

Drynaria sparsisora (Desv.) T. Moore; 14657, 14950

Lecanopteris deparioides (Ces.) Baker; 15223, 16635; NGF 45219

Lecanopteris sinuosa (Wall. ex Hook.) Copel.; 14546, 15079; Bellamy B12; NGF 44206

Microsorum scolopendria (Burm. f.) Copel.; 14360

Microsorum sibomense Copel.; NGF 45182

Pyrrosia foveolata (Alston) Morton var. *foveolata*; 15261

PSILOTACEAE

Psilotum nudum (L.) Beauv.; 14637

PTERIDACEAE

Pteris blumeana Agardh; 14684, 14717

Pteris tripartita Sw.; 15061, 15073, 15077

SCHIZAEACEAE

Lygodium microphyllum (Cav.) R. Br.; 14610

Lygodium trifurcatum Baker; 14406, 14563, 14758, 14836, 14844 (distr. as *L. dimorphum*)

Lygodium versteegii Christ; 14323, 15103, 15182; Gawi 25; Kairo 752; NGF 44201

Schizaea dichotoma (L.) Sm.; 15171; Jacobs 9545; Kog 27; Kwangut 33; NGF 47773

Schizaea digitata (L.) Sw.; 14324, 15006; NGF 39417

Schizaea wagneri Selling; NGF 45170

SELAGINELLACEAE

Selaginella cf. *schlechteri* Hieron.; 14409

Selaginella cf. *suffruticosa* v.A.v.R.; Palis 32

Selaginella sp., aff. *?melanisica* Kuhn; 14809

Selaginella sp. (possibly: *latifolia*, *puberulipes*, or *suffruticosa*); 15195

Selaginella sp.; Akia 18

TECTARIA GROUP

Tectaria bamleriana (Rosenst.) C. Chr.; SR, Bulili; NGF 45220
Tectaria durvillei (Bory) Holttum; NGF 22884 (K, nv)
Tectaria sp., aff. ?*cristovalensis* (C. Chr.) Alston; NGF 22884 (K)

THELYPTERIDACEAE

Plesioneuron croftii Holttum; Conn et al. 177; Manseima 26 (?23, two nos. given on label)
Pneumatopteris sogerensis (Gepp) Holttum; 15267
Sphaerostephanos multiauriculatus (Copel.) Holttum; 15270
Sphaerostephanos sp., aff. *novoguineensis* (Brause) Ros.; 14753, 14961, 15010, 15107

VITTARIACEAE

Antrophyum sp., *callifolium* Bl. facies; SR, Lababia
Monogramma sens. lat., closest to *Vaginularia trichoidea* Fee; Kwangut 37
Vittaria angustifolia Bl.; 15391; Unkau 98
Vittaria elongata Sw. var. *angustifolia* (Bory) Thw.; 15216
Vittaria elongata Sw. var. *elongata*; Manseima 20
Vittaria cf. *scolopendrina* (Bory) Thw.; 14775

GYMNOSPERMS

GNETACEAE

Gnetum costatum K. Sch.; 14320, 14765, 14965, 15415, 15420, 15577, 16579, 16586; Conn et al. 296; NGF 25677
Gnetum gnemon L. var. *gnemon*; 14739, 14741, 14764, 14783, 16562; LAE 68531
Gnetum latifolium Bl. var. *latifolium*; 14952

PODOCARPACEAE

Podocarpus neriifolius D. Don; 14330, 15086, 15110; NGF 28082A (K)

MONOCOTS

AMARYLLIDACEAE

Crinum asiaticum L.; SR, Tabali riverbanks

ARACEAE

Colocasia esculenta (L.) Schott; SR, cult. Lababia
Cyrtosperma macrotum Becc. ex Engl.; NGF 45172
Holochlamys beccarii Engl.; NGF 25681
Scindapsus sp.; 14638, 15080
Spathiphyllum schlechteri (Engl. & Krause) Nicolson; 15157, 16595; Conn et al. 205, 217, 237; LAE 51676; NGF 45149; Vinas & Kairo 311, 312, 314, 317
Xanthosoma sagittifolia (L.) Schott; SR, cult. Lababia

ARECACEAE

Areca cathecu L.; SR, cult. Lababia
Calamus hollrungii Becc.; SR, Saia River
Calamus sp., aff. *brevifolius* Becc.; 14956; NGF 24479 (nv)
Calamus spp.; 14426; Jacobs 9561, 9698; NGF 24469
Calyptrocalyx sp., aff. ?*stenochista* Burret; 14398
Calyptrocalyx sp.; Kjaer AB511
Caryota rumphiana Mart.; SR, Kulindi
Cocos nucifera L.; SR, cult. Lababia
Cyrtostachys glauca H.E. Moore; NGF 24460
Cyrtostachys sp.; Kjaer AB 512
Heterospathe cf. *muelleriana* (Becc.) Becc.; Kjaer AB 513
Hydriastele microspadix Becc.; 14547, 15043, 15142; LAE 52052; NGF 24427, 24477
Livistona sp. nov.; Kjaer AB 514; NGF 24466, 25682
Metroxylon sagu Rottb.; SR, Tabali River
Nypa fruticans Wurmb; SR, Tabali River
Orania lauterbachiana Becc.; NGF 24435, 24480
Orania sp.; Kjaer AB 515

BROMELIACEAE

Ananas comosus (L.) Merr.; SR, cult. Lababia

CYPERACEAE

Cladium mariscus (L.) Pohl sens. lat.; 14630
Cyperus pedunculatus (R. Br.) Kern; LAE 52301
Cyperus rotundus L. ssp. *retzii* (Nees) Kük.; 14974
Eleocharis geniculata (L.) R. & S.; 14533B; LAE 52324; NGF 44152, 44203
Fimbristylis cymosa R. Br.; 14531, 14533A
Gahnia aspera (R. Br.) Spreng.; 14578, 15063
Hypoletrum nemorum (Vahl) Spreng.; LAE 52340
Machaerina glomerata (Gaud.) Koyama; 14443, 14790, 14805, 15337, 16569; LAE 72468; NGF 28098 (K), 39432
Machaerina mariscoides (Gaud.) Kern; 14850, 16571; LAE 52327
Machaerina rubiginosa (Spreng.) Koyama; 14629
Mapania baccifera C.B. Clarke ssp. *baccifera*; 14573, 14658
Mapania macrocephala (Gaud.) K. Sch.; 14396, 14818

Mapania macrocephala (Gaud.) K. Sch. ssp. *macrocephala*; 14791; Conn et al. 262; LAE 52290
Paramapania parvibractea (Clarke) Uittien; 14640, 14656, 15083, 15563, 16612
Schoenus falcatus R. Br.; 14624, 14762, 14849
Schoenus laevinux (Kük.) Ohwi; 14907
Scleria ciliaris Nees sens. lat.; 15122, 15441
Scleria polycarpa Boeck.; 14862

DIOSCOREACEAE
Dioscorea alata L.; SR, cult. Lababia
Dioscorea esculenta (Lour.) Burk.; SR, cult. Lababia
Dioscorea nummularia Lamk.; 14346, 15070

FLAGELLARIACEAE
Flagellaria indica L.; 14331, 14564, 14930

HYDROCHARITACEAE
Enhalus acoroides (L.f.) Royle; Jacobs 9693; NGF 45190

LAXMANNIACEAE
Cordyline fruticosa (L.) A. Chev.; 14457, 14732, 14826, 15044, 16439; NGF 24453

MARANTACEAE
Phacelophrynium sp.; 14645 (distr. as *Phrynium* sp.), 16611

MUSACEAE
Musa cultivars; SR, cult. Lababia

ORCHIDACEAE (Vogel et al. colls. det. by Vogel & Schuiteman; other colls. det. by Howcroft)
Acriopsis javanica Reinw. ex Bl. var. *javanica*; 14412, 15262; NGF 45194
Acriopsis liliifolia (J. Konig) Ormerod; Vogel et al. 20030827
Agrostophyllum spp.; 14601; Vogel et al. 20030853
Apostasia wallichii R.Br.; 14415, 14748, 15202; LAE 51677; Vogel et al. 20030793, 20030832
Appendicula reflexa Bl.; Vogel et al. 20030791
Appendicula spp.; 15229; Vogel et al. 20030789, 20030790
Ascoglossum calopterum (Rchb. f.) Schltr.; 16443
Bromheadia finlaysoniana (Lindl.) Miq.; 16568; Vogel et al. 20030831
Bulbophyllum blumei (Lindl.) J.J. Sm.; 15201
Bulbophyllum gracillimum (Rolfe) Rolfe; Vogel et al. 20030823, 20030837, 20030838
Bulbophyllum cf. *macranthum* Lindl.; 14594
Bulbophyllum sessile (Koen.) J.J. Sm.; Vogel et al. 20030818
Bulbophyllum sp., sect. *Aphanobulbum*; 15389
Bulbophyllum sp., sect. *Sestochilus*; Vogel et al. 20030807, 20030814, 20030817
Bulbophyllum spp.; 15392; LAE 52323; NGF 31624; Vogel et al. 20030808, 20030809, 20030810, 20030811, 20030812, 20030813, 20030815, 20030816, 20030817, 20030829, 20030836, 20030855
Cadetia funiformis (Bl.) Schltr.; NGF 45195 (det. Schuiteman); Vogel et al. 20030800
Cadetia sp./?spp.; 15213; NGF 45121 (no flowers)
Ceratostylis sp.; 14641
Claderia cf. *papuana* Schltr.; Vogel et al. 20030788
Claderia sp.; Vogel et al. 20030856
Cleisostoma spp.; Vogel et al. 20030850, 20030851
Coelogyne asperata Lindl.; 15154, 15219
Coelogyne cf. *fragrans* Schltr.; Vogel et al. 20030796
Dendrobium austrocaledonicum Schltr.; 15071
Dendrobium bracteosum Reichb.; SR, Saia River
Dendrobium coeloglossum Schltr.; Vogel et al. 20030804
Dendrobium hosei Ridl.; 15227; LAE 52310 (600 m elev.)
Dendrobium lawesii F.v.M.; LAE 52307, 52308, 52309 (600 m elev.)
Dendrobium ?lineale Rolfe; SR, Saia River
Dendrobium macrophyllum A.Rich; 14597, 14599; Vogel et al. 20030843, 20030845, 20030846
Dendrobium spectabile (Bl.) Miq.; 14603; LAE 52330: NGF 45191; Vogel et al. 20030822, 20030842
Dendrobium viridiflorum F.M. Bailey; Vogel et al. 20030840
Dendrobium sp., sect. *Amblyanthus*; NGF 45162 (nv)
Dendrobium sp., sect. *Brevisaccata*; Vogel et al. 20030805, 20030857
Dendrobium sp., sect. *Ceratobium*; 15075
Dendrobium sp., sect. *?Distichophyllae*; Vogel et al. 20030806
Dendrobium sp., sect. *Latouria*; Vogel et al. 20030847
Dendrobium sp., sect. *Oxystophyllum*; Vogel et al. 20030803

Dendrobium sp., sect. *Spatulata*; Vogel et al. 20030828
Dendrobium spp.; 14647; Vogel et al. 20030802, 20030849
Dipodium spp.; Vogel et al. 20030821, 20030835
Eria spp.; NGF 45111; Vogel et al. 20030801
Goodyera rubicunda (Bl.) Lindl.; 15423
Habenaria chloroleuca Schltr.; NGF 25685
Lepidogyne minor Schltr.; 16603; NGF 24478 (nv)
Malaxis sp.; NGF 45161
Neuwiedia veratrifolia Bl.; 14431, 14644, 15096, 15156, 16584; NGF 24478; Vogel et al. 20030833
Paphiopedilum violascens Schltr.; 16618; NGF 45147 (nv)
Phreatia sp.; Vogel et al. 20030852
Plocoglottis sp., *maculata* facies; 15055, 15087, 15159, 16565, 16594; LAE 52037; NGF 31652, 45192, 47762
Plocoglottis sp., *sakiensis* facies; 14353; NGF 25688
Plocoglottis spp.; 14665 (inflorescence terminal); Vogel et al. 20030794
Podochilus sp., *scalpelliformis* facies; 14824
Pseuderia cf. *similis* Schltr.; 14489, 15035, 15187, 15217
Pseuderia spp.; Vogel et al. 20030834, 20030848
Rhynchophreatia sp.; 14622
?*Sarcanthopsis* sp.; 15075, 16443
Spathoglottis plicata Bl.; Vogel et al. 20030820
Spathoglottis plicata Bl. ssp. *humilis* Howcroft ined.; 14397, 14452, 14524, 14631, 15163; NGF 45095, 47766
Spathoglottis portusfinschii Krzl.; Vogel et al. 20030819
Tainia sp.; Vogel et al. 20030798
Tropidia disticha Schltr.; NGF 45122; Rau 286
Tropidia sp.; Vogel et al. 20030797
Vanilla sp.; Vogel et al. 20030786, 20030858
Vrydagzynea novaguineensis J.J. Sm.; NGF 45120
genus indets.; 14352, 14897, 15069 (bottled); Vogel 20030857

PANDANACEAE (Freycinetia dets. by K.L. Huynh)
Freycinetia curvata Huynh; 14347
Freycinetia cyrtocarpa Kaneh.; 16444
Freycinetia erythrophylla Huynh; 15265
Freycinetia funicularis (Sav. ex Lam.) Merr.; 14587, 14589, 14596, 16539; Jacobs 9668; NGF 45225
Freycinetia glaucescens Huynh; 14428
Freycinetia kamialiensis Huynh; 16474
Freycinetia longiramulosa Huynh; 15259
Freycinetia macrostachya Mart.; 14593
Freycinetia mediana Huynh; 15233
Freycinetia neoforbesii Huynh; NGF 45155
Freycinetia oraria Huynh; 14414, 14528, 14731
Freycinetia pluvisilvatica Huynh; 14694
Freycinetia rubripedata Huynh; 16440
Freycinetia sachsenensis Huynh; 14384
Freycinetia takeuchii Huynh; 14351, 14552, 16475
Freycinetia tenuis Solms.; NGF 31628 (K)
Freycinetia sp., ?*marginata* Bl.; NGF 24488 (staminate)
Freycinetia spp.; 14694; LAE 52341 (550 m elev.)
Pandanus cernuifolius Merr. & Perry; 14421, 14442
Pandanus lustrorum Stone, vel aff.; 15559
Pandanus tectorius Parkinson; 14379
Pandanus sp.; SR, Kulindi, 30 m canopy trees

POACEAE
Bambusa forbesii (Ridl.) Holttum; 15360
Bambusa vulgaris Schrad.; SR, Bitoi
Centotheca latifolia (Osb.) Trin.; 15246
Chrysopogon aciculatus (Retz.) Trin.; 14438
Eragrostis cf. *brownii* (Kunth) Nees; 14532
Eragrostis tenella (L.) P. Beauv. ex Roem. & Schult.; 14542
Eriachne triseta Nees ex Steud.; 14530
Ichnanthus vicinus (F.M. Bailey) Merr.; 14816
Ischaemum mutica L.; 14439
Nastus schlechteri (Pilger) Holttum, vel aff.; 14583, 14755, 15235, 15395, 16604, 16642
Paspalum conjugatum Berg.; 14562
Paspalum orbiculare G. Forst.; 14543
Saccharum edule Hassk.; SR, cult. Lababia
Saccharum officinarum L.; SR, cult. Lababia
Sacciolepis indica (L.) Chase; NGF 45193
Urochloa mutica (Forssk.) T.-Q. Nguyen; SR, Kulindi
Zea mays L.; SR, cult. Lababia

SMILACACEAE
Smilax cf. *calophylla* Wall. ex DC.; 14655, 15016, 15561
Smilax cf. *ovatolanceolata* Koyama; 14742, 15023
Smilax sp., '*australis-zeylanica* facies'; 14567

TRIURIDACEAE
Sciaphila tenella Bl.; NGF 45094
Sciaphila sp.; Jacobs 9546; NGF 45144

ZINGIBERACEAE
Pleuranthodium sp., *Psychanthus* facies; 14459, 14957, 14963

Riedelia corallina Val.; NGF 24452
Riedelia cf. *hollandiae* Val.; 16590, 16602, 16617
Riedelia sp. A; ?15049, 16613
Riedelia sp. B; 14383, 14446, 14754, 14960, 16623
Riedelia sp. C; 14403, 14648, 15353, 16610 (14403, 14648 distr. as *Pleuranthodium tephrochlamys*); NGF 24499, 47764

DICOTS

ACANTHACEAE

Acanthus ilicifolius L., sens. lat. (spineless form); 15361
Graptophyllum sp.; LAE 52757 (nv)
Ruellia sp. (*Leptosiphonium*); 15252
Strobilanthes sp.; 15269

ACTINIDIACEAE

Saurauia sp., aff. *schumanniana* Diels; 14356, 14417, 14557, 14579, 14623, 14787, 14918, 15032, 15045, 15443; NGF 25670, 47765; Rau 565

ANACARDIACEAE

Buchanania macrocarpa Laut.; 15221, 16589; NGF 24484
Campnosperma brevipetiolata Volk.; SR, Tabali River
Campnosperma montanum Laut.; 15066; NGF 39416, 45110
Euroschinus papuanus Merr. & Perry; NGF 25666
Semecarpus aruensis Engl.; NGF 45151
Semecarpus australiensis Engl.; Jacobs 9646; NGF 24485
Semecarpus cf. *brachystachys* Merr. & Perry; 14486, 14614, 15005, 15358; NGF 28085 (K)
Semecarpus bracteatus Laut., vel aff.; 14821, 14948, 15046
Semecarpus cassuvium Roxb.; Jacobs 9559; LAE 52336
Semecarpus forstenii Bl.; Jacobs 9594
Semecarpus sp., aff. *?schlechteri* Laut.; NGF 39436 (nv)

ANNONACEAE

Cyathocalyx cf. *polycarpum* C.T.White (*papuanus-polycarpum* group); 14819, 14910, 15402, NGF 24489 (nv), 28075 (K, nv), 31634 (K, nv), 31642 (K, nv), 45141 (nv)
Goniothalamus aruensis Scheff.; NGF 25663, 45160
Goniothalamus sp.; Jacobs 9539
Haplostichanthus longirostris (Scheff.) Heusden; NGF 25002 (K)
Mitrella sp. (*Fissistigma* s. lat.); 14693, 14912, 15388
?Petalolophus megalopus K. Sch., vel aff.; 14652, 15167, 15177 (all nos. without flowers, possibly *Pseuduvaria*)
Polyalthia cf. *oblongifolia* Burck.; NGF 25006 (K), 31638 (K)
Polyalthia spp.; 14865, 16631; Jacobs 9666, 9688; NGF 24456
Pseuduvaria ?beccarii (Scheff.) Sincl.; Conn et al. 203, 247; NGF 45137; Rau 613
Pseuduvaria sp., aff. *?filipes* Laut. & K. Sch.; 14822
Uvaria sp., *cordata-rosenbergiana* facies; 14859, 14913, 14919
Xylopia sp., aff. *peekelii* Diels; 14941, 15580
genus indet.; LAE 52034

APOCYNACEAE

Alyxia acuminata K. Sch., sens. lat.; 14698, 14766, 14977, 14985, 15025, 15145, 16563; LAE 51687, 68554; NGF 28072 (K)
Anodendron oblongifolium Hemsl.; 15433
Cerbera floribunda K. Sch.; 14516, 15344
Cerbera manghas L.; 15134
Hoya lauterbachii K. Sch.; NGF 22888 (nv)
Hoya sp. A; 14720, 14933, 15206, 15240
Hoya sp. B; 15425
Ichnocarpus wariana (Schltr.) Middleton; Jacobs 9687
Melodinus cf. *novoguineensis* (Wernh.) Pichon; 14679
Ochrosia coccinea (Teijsm. & Binn.) Miq.; 14422, 15040
Parsonsia alboflavescens (Dennst.) Mabberley; 14667, 14839, 15133, 15135
Parsonsia buruensis (Teijsm. & Binn.) Boerl.; 15137
Parsonsia curvisepala K. Sch.; 14718, 14853, 14971; NGF 25672, 45128
Sarcolobus retusus K. Sch.; 14354, 14606, 15138, 16566; Bellamy 5; Conn 174; Jacobs 9680; NGF 45114
Tabernaemontana aurantiaca Gaud.; 14395
Tabernaemontana pandacaqui Lam.; 14858, 15224
genus indet.; 15212

ARALIACEAE

Mackinlaya celebica (Harms) Philipson; SR, near Cape Roon

Mackinlaya schlechteri (Harms) Philipson; 14671, 15094, 15190, 15572; NGF 45164
Osmoxylon boerlagei (Warb.) Philipson; 15264
Plerandra stahliana Warb.; NGF 62051
Schefflera sp.; 14797, 14804, 14833

ARISTOLOCHIACEAE
Aristolochia momandul K. Sch.; 14394

ASTERACEAE
Adenostemma lavenia (L.) O. Ktze.; 15248
Bidens pilosa L. var. *minor* (Bl.) Sherff; 14436
Erigeron sumatrensis Retz.; 15204
Wedelia biflora (L.) DC.; SR, near Tabali

BEGONIACEAE
Begonia sp., *brachybotrys-pseudolateralis* facies; 15424

BIGNONIACEAE
Dolichandrone spathacea (L.f.) K. Sch.; 15268
Pandorea pandorana (Andr.) Steen.; 14852
Tecomanthe dendrophila (Bl.) K. Sch.; NGF 24467, 39434

BIXACEAE
Bixa orellana L.; SR, cult. Lababia

BURSERACEAE
Canarium lamii Leenh.; NGF 28060 (K)
Canarium salomonense Burtt; NGF 28092
Canarium vitiense A. Gray; Jacobs 9672
Canarium sp., close to *vitiense* A. Gray; NGF 31648 (K)
Haplolobus floribundus (K. Sch.) H.J. Lam; Jacobs 9673; LAE 52055; NGF 24468

CANNABACEAE
Gironniera celtidifolia Gaud.; 14404, 14708, 14779, 14921, 15378, 16640; LAE 51667; NGF 25680, 47768
Trema cannabina Lour.; 14483, 15064, 15173, 15346; Conn et al. 185, 187; NGF 31633 (K); Rau 563

CARICACEAE
Carica papaya L.; SR, cult. Lababia

CASUARINACEAE
Gymnostoma papuanum (S. Moore) L.A.S. Johnson; 14444, 14778, 14780; NGF 25665

CELASTRACEAE
Bhesa archboldiana (Merr. & Perry) Ding Hou; 15042, 15056, 15074 (distr. as *B. robusta*), 15571
Loeseneriella macrantha (Korth.) A.C. Smith; Jacobs 9619
Lophopetalum torricellense Loes.; 16600; LAE 51684
Salacia chinensis L.; 16425
Salacia erythrocarpa K. Sch.; LAE 52316
Salacia papuana (Loes.) Ding Hou; LAE 52320
Salacia sp.; NGF 45109 (carpological coll. missing, sheet sterile)

CHRYSOBALANACEAE
Hunga papuana (Baker f.) Prance; 14922, 14929, 14940, 15584
Maranthes corymbosa Bl.; 14556, 14712, 14920, 14937, 14942, 14968; NGF 31644 (K)
Parastemon versteeghii Merr. & Perry; 15021; NGF 45157
Parinari papuana C.T. White ssp. *whitei* Prance; 14885, 15015; Jacobs 9583; NGF 28063, 44202

CLUSIACEAE (Calophyllum dets. by P. Stevens)
Calophyllum goniocarpum Stevens; 14981; NGF 24474
Calophyllum inophyllum L.; 14535, 15111; Swaine 66
Calophyllum morobensis Stevens; Johns sn (LAE sheet 129181, nv); NGF 24490 (nv)
Calophyllum papuanum Laut.; 14892, 14905, 15347, 16564; LAE 52312; NGF 24487
Calophyllum streimannii Stevens; LAE 52755; NGF 24285, 24491, 28084 (K)
Calophyllum sp.; 14535
Garcinia cf. *assugu* Laut.; 16632
Garcinia celebica L.; 14416, 14419, 16413
Garcinia dulcis (Roxb.) Kurz; 15406; NGF 28066 (K)
Garcinia hunsteinii Laut.; 15050; NGF 24458
Garcinia latissima Miq.; NGF 24447, 28073
Garcinia cf. *ledermanii* Laut.; 14333, 14348, 14617, 14734, 14867, 15404
Garcinia maluensis Laut.; 15412, 16574; NGF 31646 (K)
Garcinia sinuata Stevens; 14886, 14888, 15169, 15192, 15398, 16583; NGF 24449, 45165
Garcinia sp., *assugu-maluensis* facies; 14651, 14689, 14713, 14729, 14830, 14863, 14890, 14955, 14987, 15001, 15199, 16436; LAE 52761
Garcinia sp., aff. ?*sabangensis* Laut.; 14433, 14769, 14808, 16641

Garcinia sp.?nov.;*ledermanii* facies but not *Cambogia*; 15379, 15409; NGF 24455
Garcinia spp.; 14325, 14799
Mammea papyracea Stevens; NGF 39414

COMBRETACEAE
Lumnitzera littorea (Jack) Voight; 14378, 14902; LAE 52059; NGF 39092, 44153
Terminalia canaliculata Exell; 15256
Terminalia catappa L.; SR, Lababia
Terminalia rubiginosa K. Sch.; LAE 52043
Terminalia sepicana Diels; NGF 39412

CONVOLVULACEAE
Erycibe cf.*hellwigii* Prain; 14585, 14682; LAE 51691; NGF 24471, 24498, 45100 (keys between *E. carrii* and *E. puberula*)
Ipomoea batatas (L.) Lamk; SR, cult. Lababia
Ipomoea pes-caprae (L.) R. Br.; 14544
Ipomoea pes-caprae (L.) R. Br. ssp. *brasiliensis* (L.) Ooststroom; NGF 22879
Merremia peltata (L.) Merr.; SR, Tabali River

CUCURBITACEAE
Cucumis sativus L.; SR, cult. Lababia

CUNONIACEAE
Ceratopetalum succirubrum C.T. White; sn (sterile)
Weinmannia fraxinea (D.Don) Miq.; 15053, 15054, 15150

DILLENIACEAE
Tetracera nordtiana F.v.M. var. *moluccana* (Mart.) Hoogl.; 15004

DIPTEROCARPACEAE
Anisoptera thurifera (Blanco) Bl. ssp. *polyandra* (Bl.) Ashton; SR, throughout KWMA; LAE 51965, 52039
Hopea cf. *glabrifolia* C.T.White; 14620

EBENACEAE
Diospyros cf.*elliptica* (J.R. & G. Forst.) Green; NGF 28070 (K), 31631 (K), 31632 (K), 31647 (K), 45168, 45169 (some inflorescences cymose but most simple)
Diospyros ferrea (Willd.) Bakh., sens. lat.; 14366, 14555, 14559, 14574, 14715, 14847, 14943, 14975, 15033, 15439 (preceding nos. distr. as *D. elliptica* but inflorescence not cymose), 15387; NGF 39096
Diospyros novoguineensis Bakh.; 15371, 16417; LAE 51679; NGF 24457, 28078 (K), 45148
Diospyros papuana Val. ex Bakh.; NGF 45135
Diospyros cf. *sogeriensis* Bakh.; 15029, 15098, 15381; NGF 24450, 24500
Diospyros sp., ?*'ferrea* group'; NGF 25010 (K)

ELAEOCARPACEAE
Aceratium parvifolium Schltr.; NGF 31627 (K)
Elaeocarpus dolichostylus Schltr. ssp. *dolichostylus*; NGF 45138
Elaeocarpus ledermannii Schltr.; LAE 51670, 52758; NGF 44209, 45129
Elaeocarpus sphaericus (Gaertn.) K. Sch.; 14418, 14548
Elaeocarpus sp.,*'sepikanus* group'; LAE 52048
Elaeocarpus sp.?nov.5, aff.*miegei* fide Coode; LAE 52295; NGF 25668, 28089
Sloanea pulchra (Schltr.) A.C. Smith ssp. *morobensis* Coode; NGF 25005 (K), 28067 (K), 28096 (K)
Sloanea sogerensis Bak. f., sens. lat.; 14695; Conn et al. 197; NGF 28065 (K), 31649 (K), 45117 (most colls. represent the*'schumannii* facies', cf. Coode 1981)

ERICACEAE
Paphia megaphylla Stevens ined.; 15383B, 16644

ERYTHROXYLACEAE
Erythroxylum ecarinatum Burck; 14763, 14768, 14772, 14786, 14796, 14992, 15039

EUPHORBIACEAE sens. lat. (including Phyllanthaceae)
Actephila lindleyi (Steud.) Airy Shaw; 14386, 14456, 14639, 14677, 15030, 15354, 16592; Jacobs 9538; LAE 52031; NGF 45136
Antidesma moluccanum Airy Shaw var. *moluccanum*; 15417
Antidesma polyanthum K. Sch. & Laut.; 14856, 15014
Antidesma cf. *sarcocarpum* Airy Shaw; 14972; NGF 28061 (K)
Antidesma sphaerocarpum Muell. Arg.; 14474, 14493, 15038, 15414, 15568; LAE 52051; NGF 45167
Aporosa brassii Mansf.; NGF 45133
Aporosa praegrandifolia (S.Moore) Schot; 15168; LAE 52049; NGF 45134, 45171
Breynia cernua (Poir.) Muell. Arg.; 14423, 14580, 14834, 14967; NGF 47782
Claoxylon aff. *ledermannii* Airy Shaw var. *ledermannii*; 14738, 14751 (nos. distr. as

group '*Purpurescentia*'), 15386, 15416, 16587; LAE 51669
Cleistanthus pedicellatus Hook. f.; 14749 (distr. as *Kairothamnus phyllanthoides*)
Cleistanthus sp., cf. *myrianthus* (Hassk.) Kurz; 16621; NGF 44608
Cleistanthus sp., aff. *pedicellatus* Hook. f.; 14473 (leaves obtuse, capsule lobed)
Codiaeum variegatum (L.) Bl. var. *moluccanum* (Decne) Muell. Arg.; Jacobs 9596; NGF 45143
Croton cf. *choristadenius* K. Sch.; 14747, 15151, 16442; NGF 45101, 45102
Endospermum cf. *labios* Schodde; 15255
Euphorbia hirta L.; 14435
Glochidion granulare Airy Shaw; 16412
Glochidion sp.; 14571
Kairothamnus phyllanthoides (A. Shaw) A. Shaw; LAE 52046, 73372; NGF 24462, 44211, 44602, 45108
Macaranga angustifolia Laut. & K. Sch.; 15375; NGF 25674
Macaranga bifoveata J.J. Smith; 14525, 14582, 14586, 14807, 15359, 16431
Macaranga polyadenia Pax & Hoffm.; SR, passim
Macaranga tanarius (L.) Muell. Arg.; NGF 44609 (nv)
Manihot esculenta Crantz; SR, cult. Lababia
Phyllanthus cf. *effusus* S. Moore; 14321, 14387
Phyllanthus sp.; NGF 45177
Pimelodendron amboinicum Hassk.; 14788, 15405; NGF 31640 (K), 31643 (K)
Suregada glomerulata (Bl.) Baill.; 14367, 15013, 15034

FABACEAE

Abrus pulchellus Thwaites ssp. *pulchellus*; NGF 62046
Arachis hypogaea L.; SR, cult. Lababia
Archidendron lucyi F.v.M.; 15436
Archidendron molle (K. Sch.) de Wit, vel aff.; 16524; Jacobs 9621; LAE 52760; NGF 28090 (K)
Archidendron ptenopum Verdc.; 16616; NGF 44212
Archidendron sp.; 15022
Caesalpinia crista L.; NGF 22896
Crotalaria retusa L.; 15376
Dahlbergia candenatensis (Dennst.) Prain; 14882
Derris indica (Lam.) J.J. Bennett; 14619, 15123; NGF 25686 (nv)
Derris trifoliata Lour.; SR, Tabali
Desmodium umbellatum (L.) DC.; 14361, 14450, 15117
Inocarpus cf. *papuanus* Kostermans; 14719
Intsia bijuga (Colebr.) O. Kuntze; SR, Bulili shoreline
Macropsychanthus lauterbachii Harms; SR, Saia River
Maniltoa sp., aff. *schefferi* K. Sch. & Hollrung; 14318, 15582; sp. E in Verdcourt (1979)
Mucuna schlechteri Harms; 14746, 14966, 15377; Jacobs 9640; NGF 25673, 45096
Ormosia calavensis Azaola ex Blanco; 14958
Sophora tomentosa L. ssp. *tomentosa*; Martin 2520; NGF 47774
Vigna unguiculata (L.) Walp.; SR, cult. Lababia

FAGACEAE

Lithocarpus vinkii Soepadmo; 14317, 14517 (nos. distr. as *L. celebicus*); NGF 24492, 31622 (K), 44213

GENTIANACEAE

Fagraea amabilis S. Moore; 14462 (610 m)
Fagraea berteroana A. Gray ex Wall.; Jacobs 9542; LAE 52314 (nv)
Fagraea ceilanica Thunb.; 14369, 14598, 15020
Fagraea racemosa Jack ex Wall.; 14760, 14908, 14979, 15340; Jacobs 9622; LAE 51665, 52041, 52335, 68510; NGF 22885 (K)

GESNERIACEAE

Aeschynanthus cf. *kermesinus* Schltr.; 14504
Aeschynanthus cf. *leptocladus* C.B. Clarke; 14461
Boea lawesii H.O. Forbes; LAE 62047
Boea mollis Schltr.; NGF 47781
Cyrtandra schumanniana Schltr., vel aff.; LAE 51682
Cyrtandra sp., sect. *Centrosiphon*; NGF 45173
Cyrtandra sp., sect. *Loxophyllum/Phaeotrichium*; 14458, 14485

GOODENIACEAE

Scaevola oppositifolia R. Br.; SR, Kulindi
Scaevola sericea Vahl; 14363

ICACINACEAE

Platea latifolia Bl.; 15421
Rhyticaryum longifolium K. Sch. & Laut.; 14653, 14664, 14877; Jacobs 9671

LAMIACEAE

Callicarpa longifolia Lamk.; NGF 22883 (K)
Gmelina ledermanni H.J. Lam; 14365, 14487,

14924, 15026, 15114, 15343; Jacobs 9536; NGF 28077 (K); Rau 609
Leucas flaccida R. Br.; NGF 25684
Plectranthus sp., aff. *?parviflorus* Willd.; 14437 (does not key)
Premna serratifolia L.; 14441, 14893; NGF 47784

LAURACEAE

Actinodaphne nitida Teschn.; NGF 31637 (K)
Cassytha filiformis L.; 14527, 14540
Cinnamomum eugenoliferum Kosterm.; NGF 45130
Cryptocarya cf. *densiflora* Bl.; LAE 52315
Cryptocarya laevigata Bl.; 14709, 14947, 14953, 15153, 16588, 16608
Cryptocarya multipaniculata Teschn.; 15241
Cryptocarya novoguineensis Teschn.; 16633; NGF 28086 (K)
Cryptocarya pulchella Teschn., vel aff.; 15578
Cryptocarya sp.; 14476
Endiandra engleriana Teschn.; NGF 28068 (K)
Endiandra forbesii Gamble; NGF 39098, 45187
Litsea sp., *collina* facies; 15348
Litsea sp., *guppyi* facies; 14703, 14978, 15244; NGF 24472
Persea americana Mill.; SR, cult. Lababia

LECYTHIDACEAE

Barringtonia apiculata Laut.; 15113; LAE 52053; NGF 28081 (K)
Barringtonia asiatica (L.) Kurz; SR, Lababia, also several colls. Lasanga
Barringtonia lumina Jebb ined.; SR, Saia River (un common); NGF 45145
Barringtonia pinifolia Jebb ined.; 14560, 14576, 14681, 14704 (distr. as *B. calyptrocalyx* cf. var. *boridiensis*), 16438, 16585; Jacobs 9550
Barringtonia racemosa (L.) Spreng.; 15250
Barringtonia sp., aff. *?acutangula* (L.) Gaertn.; 15364
Barringtonia sp. A; NGF 25676, listed as uniden tified 'group 2' in Jebb (1991)
Barringtonia sp. B; 14866 (distr. as *B. calyptrata* but not that species)

LINACEAE

Hugonia jenkinsii F.v.M.; 14632, 15112, 15160; Ja cobs 9603; NGF 24470

LOGANIACEAE

Geniostoma rupestre J.R. & G. Forst.; 16597; Conn et al. 175, 178, 186, 207; Jacobs 9597, 9613; NGF 24486, 47763; Rau 283, 590, 606, 608, 614, 617
Geniostoma rupestre J.R. & G. Forst. var. *rupestre*; 14448, 14480, 14714, 14727, 14752, 14832, 14838, 14855, 14931, 15072, 15442
Neuburgia corynocarpa (A. Gray) Leenh.; 15245, 15258, 15363
Strychnos minor Dennst.; 14316, 15024, 15027

LORANTHACEAE

Amyema scandens (Tiegh.) Danser ssp. *scandens*; 16432
Decaisnina hollrungii (K. Sch.) Barlow; 14551, 16421; NGF 45196
Dendrophthoe curvata (Bl.) Miq.; 14430, 14529
genus indet.; NGF 47761

MAESACEAE

Maesa haplobotys F.v.M.; 14923, 15238, 15384, 16620

MALVACEAE

Brownlowia argentata Kurz; 15275
Commersonia bartramia (L.) Merr.; 14410, 14460, 14823, 15047, 15342; Swaine 10
Heritiera littoralis Ait.; 15249; LAE 52333
Hibiscus tiliaceus L.; SR, Tabali River and Lababia beachfront
Kleinhovia hospita L.; SR, Lababia
Microcos sp.; NGF 28069 (K)
Sida cordifolia L.; 14434
Sterculia cf. *lepidostellata* Milbr.; 14820
Sterculia morobeensis Tantra; Jacobs 9663; NGF 28093 (K)
Sterculia schumanniana (Laut.) Mildbr.; 14721; Conn et al. 211; LAE 62045; NGF 28076 (K)
Sterculia sp. ?nov., aff. *shillinglawii* F.v.M.; 14591, 14743, 14803, 15181
Sterculia sp. nov., fide Tantra (1976); Jacobs 9639
Thespesia populnea (L.) Sol. ex Correa; SR, Lababia

MELASTOMATACEAE

Astronidium morobiense Maxw.; 15351, 15560, 16223 (dets. S.S. Renner); NGF 25658 (nv) and 45180 (nv) could be this sp.
Medinilla sp., aff. *tenuipedicellata* Bak. f.; 14795
Medinilla spp.; 15365, 16615
Melastoma malabathricum L. ssp. *malabathricum*; 14372, 15121 (distr. as *M. af fine* D. Don)
Poikilogyne sp.; NGF 45232

MELIACEAE

Aglaia brownii C.M. Pannell; 14911; NGF 24446
Aglaia cf. *rimosa* (Blanco) Merr.; 14666, 15076
Aglaia sapindina (F.v.M.) Harms; 14427, 15230, 15266, 15366, 15574, 16222; Jacobs 9576, 9607; NGF 45140; Warete-Namorong 7
Aglaia tomentosa Teijsm. & Binn.; 15407, 15422, 16643
Aglaia sp., aff. ?*agglomerata* Merr. & Perry; 14332, 14482, 15179 (distr. as *A. silvestris*, vel aff.), 15419, 15576; NGF 45183
Aglaia sp., aff. ?*sapindina* (F.v.M.) Harms; 14393, 15175, 15191, 15350; LAE 52054
Aphanamixis polystachya (Wall.) R.N. Parker; 15434
Chisocheton lasiocarpus (Miq.) Val.; 15257, 15429
Chisocheton lasiocarpus (Miq.) Val. entity *'schlechteri'*; 15041, 15104, 15161, 15176, 16599; LAE 52343
Chisocheton lasiocarpus (Miq.) Val. entity *'weinlandii'*; LAE 62059
Chisocheton sapindinus Stevens; 14336, 15411, 15574, 16414; NGF 45140
Dysoxylum arborescens (Bl.) Miq.; LAE 51686
Dysoxylum papuanum (Merr. & Perry) Mabb.; LAE 52319
Vavaea amicorum Benth.; NGF 24482
Xylocarpus granatum Koen.; 14634, 14899

MEMECYLACEAE

Memecylon sp., *sepicana-schraderbergense* facies; 14670; NGF 25003

MENISPERMACEAE

Hypserpa polyandra Becc. var. *polyandra*; 14553, 14744, 15078; Jacobs 9653; LAE 51673; NGF 24473
Macrococculus pomiferus Becc.; LAE 62057

MONIMIACEAE

Kairoa suberosa Philipson; 15430
Kibara oblongata Philipson, vel aff.; 14334, 15012
Levieria nitens Perkins; NGF 24439 (nv)
Steganthera hirsuta (Warb.) Perkins; 14575, 14706, 15164; NGF 25687

MORACEAE

Artocarpus communis J.R. & G. Forst.; SR, Tabali River
Ficus adenosperma Miq.; 14359
Ficus ampelas Burm. f.; 14565, 14581, 14592, 14726; NGF 45118
Ficus arfakensis King; 15263
Ficus benjamina L.; LAE 52300, 68522; NGF 44154
Ficus calodictya Summerh.; 14962
Ficus gul Laut. & K. Sch.; 15019, 15222, 15272
Ficus hystricicarpa Warb.; 14687, 14964
Ficus irritans Summerh.; 14691, 14970
Ficus itoana Diels; 14626
Ficus odoardi King; NGF 51671
Ficus pachystemon Warb.; 14491, 14569, 14584, 14673, 14696, 15210, 15401, 15569B (some nos. merging with *F. subtrinervia* Laut. & K. Sch.)
Ficus rhizophoriphylla King; NGF 28087 (K)
Ficus trachypison K. Sch. var. *pallida* Corner; LAE 52759
Ficus wassa Roxb.; NGF 31645 (K)
Parartocarpus venenosus (Zoll. & Mor.) Becc. ssp. *papuanus* (Becc.) Jarrett; NGF 25001 (K)
Prainea papuana Becc.; NGF 45150

MYRISTICACEAE

Gymnacranthera farquhariana (Hook. f. & Th.) Warb. var. *zippeliana* (Miq.) R. Schouten; 14337, 14680, 14872, 14945, 14954A, 15410, 16625, 16626, 16627, 16628
Horsfieldia hellwigii (Warb.) Warb.; 15435
Horsfieldia laevigata (Bl.) Warb. var. *laevigata*; LAE 51683, 52030
Horsfieldia pilifera Markgrf.; Jacobs 9609, 9609A; LAE 52756; NGF 28080 (nv)
Horsfieldia sylvestris (Houtt.) Warb.; 15271
Horsfieldia tuberculata (K. Sch.) Warb. var. *tuberculata*; 14549
Myristica chrysophylla Sincl. ssp. *chrysophylla*; 14735, 14951, 15438; Jacobs 9574; LAE 52032, 52062; NGF 45166
Myristica chrysophylla Sincl. cf. ssp. *entrecasteauxensis* (Sincl.) de Wilde; 14335, 14602, 15018, 15082, 15130; LAE 52029
Myristica cornutiflora Sincl. ssp. *elegans* de Wilde; 14590, 14860
Myristica filipes de Wilde; 14566, 14700, 14935; Conn et al. 182, 281 (nv); LAE 51668, 52061 (nv); NGF 45115, 45116
Myristica globosa Warb.; Jacobs 9572
Myristica markgraviana A.C. Smith; LAE 52027
Myristica sulcata Warb.; Jacobs 9685; LAE 52028
Myristica tubiflora Bl.; NGF 45142
Myristica umbrosa Sincl.; 14600, 15188; LAE 52033, 52047, 52287, 52332; NGF 25659

Myristica sp. ?nov.; 14340, 14661, 15011, 15109, 15397, 16424, 16573
Myristica sp.; 16591

MYRSINACEAE

Aegiceras corniculatum (L.) Blanco; 15274
Conandrium polyanthum (Laut. & K. Sch.) Mez; 14338, 14447, 14570, 14761, 14774, 14825; LAE 52040, 52050
Discocalyx kaoyae Pipoly & Takeuchi ined.; 16441
Discocalyx orthoneura K. Sch.; NGF 24451
Discocalyx sp.; Jacobs 9584 (nv)
Fittingia tubiflora Mez; 14425, 14429, 14445, 14572, 14991, 14997, 14999, 16580, 16582, 16596, 16622; LAE 52302
Fittingia urceolata Mez; Conn et al. 284; Jacobs 9644; NGF 45139, 45163; Rau 291
Myrsine leucantha (K. Sch.) Pipoly; NGF 24429, 45235 (nv)
Myrsine rawacensis A. DC.; 14604, 15562; NGF 44603
Myrsine sp., (*Rapanea ?lamii* Sleumer); 14469

MYRTACEAE

Decaspermum bracteatum (Roxb.) A.J. Scott var. *bracteatum*; 14611, 14770, 14782, 14792, 15007, 16567; LAE 52322
Eucalyptopsis papuana C.T. White; LAE 52296, 52331, 52334; NGF 28097 (K)
Lophostemon suaveolens (Sol. ex Gaertn.) P.G. Wilson & J.T. Waterh.; 15116
Myrtella beccarii F.v.M.; 14349, 14380, 14814, 15583; Bellamy 6; Jacobs 9650; LAE 52292, 72469; NGF 44151; Paijmans 1564; Swaine 8; Watt sn
Octamyrtus insignis Diels; NGF 25018
Psidium guajava L.; SR, cult. Lababia
Rhodamnia blairiana F.v.M. var. *propinqua* (C.T. White) A.J. Scott; 14405, 14841; NGF 44215
Rhodomyrtus pinnatinervis C.T. White; LAE 52304 (600 m)
Syzygium buettnerianum (K. Sch.) Niedenzu, vel aff.; Jacobs 9677; LAE 52297
Syzygium claviflorum (Roxb.) Cowan & Cowan; 14477
Syzygium effusum (A. Gray) C. Muell., sens. lat.; 14315; NGF 24483, 45159
Syzygium cf. *flavescens* (Ridley) Merr. & Perry; 14341
Syzygium furfuraceum Merr. & Perry; 14740, 14944; NGF 31635 (K), 31650 (K)
Syzygium leptoneurum Diels; 15194; NGF 39095, 47770; Swaine 9
Syzygium longipes Merr. & Perry; 14388
Syzygium nutans (K. Sch.) Merr. & Perry; Jacobs 9629; NGF 24459
Syzygium richardsonianum Merr. & Perry, vel aff.; 14733, 14954B, 15084, 15144, 15399; LAE 51663; NGF 24476, 39431
Syzygium subcorymbosum Merr. & Perry; LAE 52289, 52317; NGF 45106
Syzygium thornei Hartley & Perry; NGF 24428
Syzygium trivene (Ridley) Merr. & Perry; 14381, 14402, 14413, 14484, 14518, 14588, 14618, 14688, 14737, 14851, 14969, 14994, 14998, 15396, 15437, 15569A, 16434, 16581; Jacobs 9617, 9645; LAE 51664; NGF 24497, 25657, 39419, 44155
Syzygium cf. *trivene* (Ridley) Merr. & Perry; 14773, 14811, 14835, 14845; NGF 25669 (nonconformist nos. with persisting bracts but cf. Hartley & Perry 1973: 213)
Syzygium viburnoides Diels; 14479
Syzygium xylopiaceum (Diels) Merr. & Perry; Jacobs 9654; LAE 52291
Syzygium sp., =*Acmena acuminatissima* (Bl.) Merr. & Perry; NGF 28095 (K)
Syzygium sp., aff. *malaccense* (L.) Merr. & Perry; 15349
Syzygium sp., aff. ?*rostratum* (Bl.) DC.; 15127
Syzygium sp. ?nov.; aff. *pyriforme* Merr. & Perry; 15382, 16607
Syzygium sp. ?nov., aff. couplet 57a or 88a; 14723, 14724, 14725
Syzygium sp.; 15095
Syzygium sp.; 15428
Tristaniopsis macrosperma (F.v.M.) P.G. Wilson & J.T. Waterh.; 14343, 15058, 15131, 15579; NGF 24464, 44607; Vinas & Kairo 295
Tristaniopsis oreophila (Diels) P.G. Wilson & J.T. Waterh.; NGF 42638
Xanthostemon petiolatus (Val.) P.G. Wilson; 15147, 15345

NEPENTHACEAE

Nepenthes neoguineensis Macf.; 14453, 14697; 14837 (distr. as *N. mirabilis*), 15573, 16435; Jacobs 9651, 9658; LAE 52313; NGF 24461, 24463; Rau 571; Watt 31

NYCTAGINACEAE

Pisonia longirostris Teijsm. & Binn.; LAE 62049

NYSSACEAE

Mastixia kaniensis Melch. ssp. *kaniensis*; LAE 52339

OCHNACEAE

Brackenridgea forbesii Tieg.; 16629; NGF 25004 (K), 28091 (K), 44205

Schuurmansia henningsii K. Sch.; 15220; NGF 31620 (K), 39413, 39430

OLACACEAE

Anacolosa papuana Schellenb.; 16624

OLEACEAE

Chionanthus ramiflorus Roxb.; LAE 62048

Chionanthus rupicolus (Lingelsch.) Kiew; 14385, 14607, 14672, 14883, 15149 (distr. as *C. ramiflorus*); Bellamy 9; LAE 52325; NGF 24465; Rau 572

Chionanthus sessiliflorum (Hemsl.) Kiew; LAE 62060

Jasminum schumannii Lingelsh.; LAE 62050

OXALIDACEAE

Averrhoa bilimbi L.; 14408, 14817

PANDACEAE

Galearia celebica Koord. var. *celebica*; 14660, 14927, 15037, 15209, 15400, 15403; LAE 51672

PASSIFLORACEAE

Adenia heterophylla (Bl.) Koord. ssp. *heterophylla*; NGF 62062

Passiflora foetida L.; SR, Lababia

PENTAPHYLACACEAE

Eurya sp./?spp.; 14463; NGF 24431 (nv), 45234 (nv)

PIPERACEAE

Piper aduncum L.; 15273

Piper celtidiforme Opiz.; 15243

Piper lessertianum (Miq.) C. DC.; 14432, 14455, 14828

Piper macropiper Pennant; 14561

Piper novoguineense Warb.; 14345

Piper pseudoamboinense C. DC.; NGF 25678

Piper versteegii C. DC.; LAE 51689

Piper sp.; 14314

POLYGALACEAE

Eriandra fragrans Royen & Steen.; 14376, 14683, 14777, 14871, 14873, 14874, 14875, 14946, 15239, 15380

Polygala paniculata L.; 14375

POLYOSMACEAE

Polyosma sp., aff. *forbesii* Val.; 14329, 14466, 14884, 14894, 15090, 15413; NGF 52337

PROTEACEAE

Bleasdalea papuana (Diels) Domin; LAE 52344 (550 m)

Finschia chloroxantha Diels; 14364, 15146; LAE 52060, 52345; NGF 45119, 47783

Grevillea papuana Diels; 14449, 14521

Helicia obtusata Sleum.; LAE 51685, 52038, 52288, 52298

Stenocarpus moorei F.v.M.; 14526, 14534, 14984, 14989, 15394, 16426; LAE 52044, 52294, 52326; NGF 39091

RHAMNACEAE

Alphitonia excelsa (Fenzl) Reiss. ex Endl. (sensu Schirarend); 15335, 15374; Jacobs 9667

Alphitonia macrocarpa Mansf.; 15408; NGF 25664

RHIZOPHORACEAE

Bruguiera gymnorrhiza (L.) Lamk; 14377

Ceriops tagal (Perr.) C.B. Rob.; 15148B; Bellamy 16; LAE 68539

Gynotroches axillaris Bl.; 15091, 15570; Jacobs 9684; NGF 24494, 31641 (K)

Rhizophora apiculata Bl.; LAE 68537, 68543

Rhizophora stylosa Griff.; 15143

ROSACEAE

Rubus fraxinifolius Poiret; LAE 62052

RUBIACEAE

Anthorrhiza echinella Huxley & Jebb; 14470 (distr. as *Myrmecodia tuberosa*); NGF 39094, 45103

Atractocarpus macarthurii (F.v.M.) Puttock; Jacobs 9580

Atractocarpus sp., =*Randia sphaerocarpa* K. Sch. & Laut.; NGF 24454

Atractocarpus sp.; 14342, 14370, 14472, 14676, 14707, 14711, 14928, 15081, 15369, 15370; NGF 25009 (K), 39093, 45152, 47777

Canthium sp., sens. lat.; 14654, 15100, 15136, 15237; Heads 268; NGF 39429, 45158, 47760, 47772; Rau 287

Gardenia lamingtonii F.M. Bailey; NGF 45185

Gardenia sp. nov.; 14864, 15101, 15558, 15575; NGF 25675, 45156

Gynochthodes aff. *verticillata* (Val.) Hosokawa; 14692, distr. as *'Randia'*

Hedyotis corymbosa (L.) Lam.; 14541

Hedyotis pubescens Val.; NGF 45176

Hydnophytum hellwigii Warb.; 15207; NGF 25662, 45105
Hydnophytum cf. *radicans* Becc.; LAE 62058
Hydnophytum sp. A; 14399
Hydnophytum sp. B; 14949; Jacobs 9669
Ixora sp. A; 14322, 14371, 14392, 14625, 14628, 14854, 14887, 14926, 14936, 14938, 14976, 15000, 15003, 15119, 15341; LAE 51675, 52042, 62061; NGF 24495, 31630 (K), 45179
Ixora sp. B; 14481, 15009, 15105, 15385, 15581, 16420, 16609
Lasianthus sp., *papuanus-chlorocarpus* facies; 15178, 15197
Morinda citrifolia L.; 14424, 15368; Conn 320; Jacobs 9702; LAE 52293; NGF 47769
Morinda umbellata L.; 14478, 14635
Mussaenda ferruginea K. Sch.; 14757
Myrmecodia tuberosa Jack; 14730
Nauclea orientalis (L.) L.; 15254
Nauclea tenuiflora (Havil.) Merr.; NGF 22886 (K)
Neonauclea clemensii Merr. & Perry; NGF 22489
?Porterandia, =*Randia ixoraeflora* Wernh.; Jacobs 9689; NGF 51688, 52057
Psychotria amplithyrsa Val.; 15166; NGF 51680
Psychotria archboldii Sohmer var. *archboldii*; 14904, 14906, 15028, 16415, 16422
Psychotria bulilimontis var. *aestuarii* Takeuchi; 14990, 14993, 14995, 15002
Psychotria bulilimontis Takeuchi var. *bulilimontis*; 16416, 16428
Psychotria croftiana Sohmer; 14490, 15048, 15139, 15566, 16430B, 16578; Jacobs 9636
Psychotria diplococca Laut. & K. Sch. var. *diplococca*; 15432
Psychotria cf. *leiophloea* Merr. & Perry; 15234, 15236, 16430A
Psychotria leonardii Merr. & Perry; 15057
Psychotria leptothyrsa Miq. var. *leptothyrsa*; 14492; Jacobs 9567
Psychotria membranifolia Bartl. ex DC.; 14488, 14750, 14831, 15184, 15203, 16575, 16577, 16606
Psychotria micralabastra (Laut. & K. Sch.) Val., 15068, 15339, 15426, 15427; NGF 31651 (K)
Psychotria micrococca (Laut. & K. Sch.) Val.; Conn et al. 278 (nv)
Psychotria olivacea Val.; 14771, 14827, 14898, 14900, 15108, 15189, 15357, 16437; Jacobs 9638; NGF 28083 (K)
Psychotria waiuensis Sohmer; 14310; NGF 25626
Psychotria sp. ?nov.; 15170, 15174A, 16593; Vinas & Kairo 304
Psychotria sp. (liane); LAE 62053
Psydrax sp., =*Canthium cymigerum* (Val.) B.L. Burtt; 14382, 14784, 14810; NGF 24475, 25667
Scyphiphora hydrophyllacea Gaertn.; 14636; NGF 45112
Timonius paiawensis S. Darwin; 14362, 14440, 14520, 14522, 15065, 15338; Conn et al. 301, 313; LAE 52328; NGF 39097, 47767
Timonius timon (Spreng.) Merr. var. *buloloensis* S. Darwin; 14362B; Jacobs 9626; NGF 44207
Timonius timon (Spreng.) Merr. var. *timon*; 15367
Timonius sp., aff. *rufescens* (Miq.) Boerl.; 14798, 14870
Timonius sp. ?nov.; 14328, 14663, 14781, 15106, 15567
Uncaria lanosa Wall. var. *appendiculata* (Benth.) Ridsd.; 14767
Urophyllum glaucescens Val., vel aff.; 14401, 14891, 15089; Jacobs 9565, 9692; LAE 52056, 52299, 52338; NGF 24448, 28094 (K), 31621 (K), 31626 (K), 45132; Rau 607, 612
Xanthophytum papuanum Wernh.; 14454, 16418; NGF 44210, 45184

RUTACEAE

Acronychia trifoliolata Zoll. & Mor.; 14901, 15118, 15148, 16419
Flindersia laevicarpa White & Francis var. *heterophylla* (Merr. & Perry) Hartley; 14519, 15124, 15132; NGF 31636
Halfordia drupifera F.v.M.; 14344
Melicope denhamii (Seem.) Hartley; 14420, 14523, 14736, 15031
Melicope xanthoxyloides (F.v.M.) Hartley; 15373
Zanthoxylum novoguineense Hartley; 14699, 14759, 14785, 14801, 14813 (distr. as *Euodia* aff. '*alata-mollis* group') 16645; LAE 52311, 52329; NGF 25690
genus indet.; 15564

SABIACEAE

Sabia pauciflora Bl.; 15431

SALICACEAE

Casearia erythrocarpa Sleumer, vel aff.; 14327, 14339, 14368, 14451, 14701, 14806, 14846, 14861, 14909, 14988, 15355; NGF 25671, 28082 (K)
Casearia cf. *macrantha* Gilg; 14848, 14916, 14939, 15162; NGF 52045

Casearia sp., aff. *flexicaulis* K. Sch.; 14357, 14545, 14605, 14616, 14829, 14959, 15115 (14357, 14616, 14829 distr. as *Glochidion* sp.); LAE 51681; NGF 25661
Casearia sp., closest to ?*novoguineensis* Val.; 15418, 16605
Homalium d'entrecasteauxense Craven; 14650, 14876
Scolopia novoguineensis Warb.; 14612, 14627
Trichadenia sasae Takeuchi; 15589, 16561

SANTALACEAE
Exocarpos latifolius R.Brown; 14889, 15120, 15372, 16423; LAE 51666; NGF 39418
Scleropyrum aurantiacum (Laut. & K. Sch.) Pilger; 15198; NGF 31629 (K), 45131, 45174

SAPINDACEAE
Alectryon ferrugineus (Bl.) Radlk.; 14728, 14802, 15247
Arytera cf. *litoralis* Bl.; 14925
Cnesmocarpon discoloroides Adema; 15092; NGF 25007
Dictyoneura obtusa Bl. ('Morobe race' oblique leaflets); 15362, 16427
Euphorianthus euneurus (Miq.) Leenh.; LAE 52318
Guioa grandifoliola Welzen; 14980; Conn et al. 195, 319 (nv); NGF 45154
Guioa rigidiuscula Radlk., or '*rigidiuscula* com plex'; 15208, 16614
Harpullia longipetala Leenh.; 15165; NGF 25679
Harpullia ramiflora Radlk.; LAE 62055 (nv)
Mischocarpus pyriformis (F.v.M.) Radlk. ssp. *papuanus* (Radlk.) Ham; NGF 47775
Pometia pinnata J.R. & G. Forst.; NGF 31639
Sarcopteryx squamosa (Roxb.) Radlk.; NGF 44208, 45099
?*Synima* aff. *cordierorum* (F.v.M.) Radlk.; 14550, 14577, 14633
genus indet.; NGF 45216 (nv; .isted as *Elattostachys* in LAE logbook)

SAPOTACEAE
Magodendron mennyae Vink; 16570; Conn et al. 194; Jacobs 9537; NGF 24436, 45146
Palaquium cf. *warburgianum* Schltr.; 15085
Pichonia sp., ?*lauterbachiana* (H.J. Lam) Pennington; 14558, 14568, 14793, 14982, 14986 (nos. distr. as *Pouteria sarcospermoides* H.J. Lam); LAE 51674; NGF 39435, 44605, 45107
Pouteria ledermannii (K. Krause) Baehni; 14471, 15088 (dets. W. Vink)
Pouteria luzoniensis (Merr.) Baehni; 14355
Pouteria maclayana (F.v.M.) Baehni; Jacobs 9573
Pouteria obovoidea H.J. Lam; NGF 24496
genus indet.; NGF 45188

SIMAROUBACEAE
Quassia indica (Gaertn.) Nooteboom; 14389

SOLANACEAE
Capsicum anuum L.; SR, cult. Lababia
Solanum anfractum Symon; Jacobs 9558; NGF 24441
Solanum melongena L.; SR, cult. Lababia
Solanum symonianum Takeuchi; 12027

STEMONURACEAE
Gomphandra ?*pseudoprasina* Sleum.; LAE 62056 (nv)
Stemonurus ammui (Kaneh.) Sleum.; 14400, 14756, 14857, 14983; NGF 24481 (nv)

SYMPLOCACEAE
Symplocos cochinchinensis (Lour.) S. Moore; 14464, 15008, 15152

THEACEAE
Gordonia papuana Kobuski; 15093, 16576; NGF 31625 (K)

THYMELAEACEAE
Phaleria coccinea (Gaud.) F.v.M.; 14745, 15017, 15193, 15218, 15565; NGF 28062 (K)
Phaleria macrocarpa (Scheff.) Boerl.; 16601

URTICACEAE
Dendrocnide longifolia (Hemsl.) Chew; 15260
Poikilospermum sp.; 14934

VERBENACEAE
Stachytarpheta cayennensis (Rich.) M.Vahl; 14537

VITACEAE
Cissus sp., '*javana-discolor* group'; Jacobs 9592
Tetrastigma sp.; NGF 28074 (K; Leiden det. ticket gives *T. pedunculare*)

WINTERACEAE
Zygogynum sp.; 14465

FAMILY INDET.; 14373, 14374, 14675

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BOOK NOTICES

Systematics/Monographs/Floras/Guides

S.S. KHARKEVICH (chief ed.) and N.N. TZVELEV (vol. ed.). 2003. **Vascular Plants of the Russian Far East. Volume 1: Lycopodiophyta, Juncacaceae, Poaceae (Gramineae).** (ISBN 0-8093-2421-0, pbk.) Science Publishers, Inc. c/o Enfield Distribution Co., 234 May Street, P.O. Box 699, Enfield, NH 03748, U.S.A. (Orders: 603-632-7377, 603-632-5611 fax, http://www.scipub.net, sales@scipub.net, complete catalog at info@scipub.net/catalog). $165.00, 506 pp, 26 plates of b/w drawings, 162 maps, 6" × 9 1/2".

This volume is actually a translation of *Sosudistye rasteniya sovetskogo Dalnego Vostoka*, 1985. There are keys to genera and species. Species descriptions include name and nomenclatural citation, Russian name, morphological description, chromosome number, and distribution by region followed by ecology, sporing/flowering time, economic uses, and notes on conservation. Running heads with family/genus would have been nice; the index does work.

DOUGLAS J. FUTUYMA, H. BRADLEY SHAFFER, and DANIEL SIMBERLOFF (eds). 2002. **Annual Review of Ecology and Systematics: Volume 33, 2002.** (ISBN 0-8243-1433-6, hbk; ISSN 0066-4162). Annual Reviews Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (Orders: www.AnnualReviews.org, 800-523-8635, 650-493-4400, 650-424-0910 fax). $145.00 (USA), $150.00 (Int'l.), 828 pp., 6" × 9".

Volume 33 of *Annual Review of Ecology and Systematics* contains a mix 25 articles: **Saproxylic Insect** Ecology and the Sustainable Management of Forests; **Conus** Venom Peptides: Reflections from the Biology of Clades and Species; **Troubleshooting** Molecular Phylogenetic Analyses; **The Early Radiations** of Cetacea (Mammalia): Evolutionary Pattern and Developmental Correlations; **The Mesozoic** Radiation of Birds; **Plant Ecological** Strategies: Some Leading Dimensions of Variation Between Species; **Reproductive** Protein Evolution; **The Causes** and Consequences of Ant Invasions; Gulf of Mexico Hypoxia, a.k.a. "the Dead Zone"; **The (Super) Tree** of Life: Procedures, Problems, and Prospects; **Homogenization** of Freshwater Faunas; **The Renaissance** of Community-Based Marine Resource Management in Oceania; **Nutrient** Cycling by Animals in Freshwater Ecosystems; **Effects of Uv-B** Radiation on Terrestrial and Aquatic Primary Producers, **The Evolution** and Maintenance of Androdioecy; **Mast Seeding** in Perennial Plants: Why, How, Where?; **Disturbance** to Marine Benthic Habitats by Trawling and Dredging: Implications for Marine Biodiversity; **Phylogenies** and Community Ecology; **Stable Isotopes** in Plant Ecology; **The Quality** of the Fossil Record: Implications for Evolutionary Analyses; **Neopolyploidy** in Flowering Plants; **Herbivore** Offense; **The Pacific Salmon** Wars: What Science Brings to the Challenge of Recovering Species; **Estimating Divergence** Times from Molecular Data on Phylogenetic and Population Genetic Timescales; **The Fate of Clades** in a World of Recurrent Climatic Change: Milankovitch Oscillations and Evolution.

Each volume has a Subject Index, Cumulative Index of Contributing Authors (vols. 29–33) and Cumulative Index of Chapter Titles (vols. 29–33)

NEW COMBINATION IN *EURYBIA* (ASTERACEAE: ASTEREAE) FROM NORTH AMERICA

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ABSTRACT

A new combination is reported here for an infraspecific taxon in *Eurybia* from North America: ***Eurybia glauca*** (Nutt.) G.L. Nesom var. ***pulchra*** (S.F. Blake) Brouillet, comb. nov.

RESUMEN

Se realiza una nueva combinación para un taxon infraspecífico en *Eurybia* de Norte América: ***Eurybia glauca*** (Nutt.) G.L. Nesom var. ***pulchra*** (S.F. Blake) Brouillet, comb. nov.

INTRODUCTION

The North American genus *Eurybia*, segregated from *Aster* by Nesom (1994), has now been shown convincingly to be distinct from the Eurasian *Aster* s.str. (Noyes & Rieseberg 1999; Brouillet et al. 2001a, b; Bastien & Brouillet 2002; Semple et al. 2002). Nesom (1994, 1997) provided most of the combinations needed in this genus. Nevertheless, during preparation of the treatments of this genus for the Flora of North America project, differences in taxonomic concepts from those suggested by Nesom (1994) have led me to propose a new combination.

Eurybia glauca (Nutt.) G.L. Nesom

In his taxonomy of *Eurybia*, Nesom (1994) recognized *Eurybia pulchra* (S.F. Blake) G.L. Nesom as a species distinct from *Eurybia glauca* (Nutt.) G.L. Nesom, justifying it by the smaller leaves, more acute phyllaries and glandularity. Yet, except for glandularity, which does not appear to vary gradually from one taxon to the other, the other features all fit within the range encountered in *E. glauca*, apart from a slight tendency toward larger reproductive features in *E. pulchra*; leaf size ranges overlap considerably when a large sample of *E. glauca* is considered. A morphometric study would be needed to determine the exact amplitude and significance of size differences between the two taxa. The ranges of the two taxa appear to be parapatric in southern Utah-northern Arizona, with *E. pulchra* restricted to the vicinity of the Grand Canyon while *E. glauca* ranges widely to the north and east into the Southern Rocky Mountains; it must be

noted, however, that populations of the latter are found in Arizona south and east of the Grand Canyon. Nonetheless, no mixed population of the two taxa has been reported. The restricted range and distinct glandularity justify that *E. pulchra* be recognized as a taxon. Nevertheless, glandularity alone does not seem to justify recognizing *E. pulchra* as a distinct species. I agree with Nesom (1994) that the inclusion by Cronquist (1994) of *E. pulchra* within *E. wasatchensis* is misguided as it is based only on the shared possession of glands. Several characters distinguish *E. pulchra* and *E.wasatchensis*, including leaf glaucousness and phyllary habit (appressed vs squarrose), which the former shares with *E. glauca*. Therefore, I prefer to recognize the former as a variety of the latter, as is done by Welsh et al. (1987), even though it was originally described as a subspecies.

Eurybia glauca (Nutt.) G.L. Nesom var. **glauca**

Eurybia glauca (Nutt.) G.L. Nesom var. **pulchra** (S.F. Blake) Brouillet, comb. et stat. nov. BASIONYM: *Aster glaucodes* S.F. Blake subsp. *pulcher* S.F. Blake, Proc. Biol. Soc. Washington 35:174. 1922. *Eurybia pulchra* (S.F. Blake) G.L. Nesom, Phytologia 77:261. 1994.

The combination *Aster glaucodes* Blake var. *pulcher* (Blake) Kearney & Peebles, reported in Welsh et al. (1987), is not valid because Kearney and Peebles (1960) did not make a formal status change with proper reference to the basionym. The name was thus never validly published at the varietal rank. These author perhaps unwittingly referred to the infraspecific taxon as a variety instead of a subspecies and might not have intended to make a new combination.

The origin of glandularity in *E. glauca* var. *pulchra* and *E. wasatchensis*, as compared to the eglandular *E. glauca* var. *glauca*, could be explained by considering the other members of section *Herrickia*, to which these taxa clearly belong: *Eurybia horrida* (Wooton & Standl.) G.L. Nesom (formerly *Herrickia horrida*) and *Aster kingii* (Brouillet et al. 2001a, b). All members of section *Herrickia* are glandular except *E. glauca* var. *glauca*. It is more parsimonious to explain the lack of glands in the latter by a loss of glands after speciation. This hypothesis would imply that the presence of glands in var. *pulchra* is ancestral within the species, and that var. *glauca* may represent a relatively more recent expansion of an eglandular phenotype to the range of the species as known today, from a more restricted original area perhaps close to the San Juan river basin where var. *pulchra* is restricted today.

ACKNOWLEDGMENTS

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BOOK NOTICES

Systematics/Monographs/Floras/Guides

JAMES B. PHIPPS with ROBERT J. O'KENNON and RON W. LANCE. 2003. **Hawthorns and Medlars.** (ISBN 0-88192-591-8, hbk.). Royal Horticultural Society Plant Collector Guide. Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $24.95, 180 pp., 75 color photos, 4 b/w photos, 2 tables, 11 drawings, 3 maps, 7 × 9".

Hawthorns (*Crataegus*) and medlars (*Mespilus*) are in the rose family (Rosaceae). This 180 page book is beautifully illustrated and adorned with excellent color photos from a variety of sources. The author brings together in one place a broad mix of information on these two groups of closely related plants. "There are perhaps 140 species of *Crataegus* in the world"; chapter seven of the book covers "69 wild and hybridogenous species and their more commonly available cultivars." Chapters include **1)** Hawthorns and Medlars in Folklore; **2)** Natural History and Conservation, Structure and Reproductive Biology; **3)** Practical Value; **4)** Cultivation; **5)** Breeding and Selection; **6)** Classification and Identification; **7)** Hawthors; and **8)** Medlars and Intergeneric Hybrids. There are four appendices: **1)** Preparation of Herbarium specimens; **2)** Checklist of *Crataegus* and *Mespilus* Species; **3)** Tabular Key to Hawthorns and Medlars; and **4)** Conversion Charts. A Glossary, Bibliography, and Index complete the book.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

PAUL L. COMEAU, YASMIN S. COMEAU, and WINSTON JOHNSON. 2003. **The Palm Book of Trinidad and Tobago including the Lesser Antilles.** (ISBN 0-9740870-0-9, pbk.). The International Palm Society, 6729 Peacock Road, Sarasota, FL 34242, U.S.A. (Orders: The Allen Press, P.O. Box 1897, Lawrence, KS 66044-8897, U.S.A., 785-843-1274 [credit card orders only]; online order www.palms.org). $39.95, 108 pp., numerous color photos, distribution maps, 7 1/2 × 10".

Contents.—Foreword, Preface, Acknowledgments, **1)** Introduction, **2)** Learning to Identify Native Palms (Identification Key for the Palms), **3)** Palms with Peculiar Distributions, **4)** Palms of the Lesser Antilles, Glossary, Nomenclatural Notes on the Palms, Making Sense of Common Names, Palm Species and Their Synonyms, Known Introduced Palms, Photograph Data, References, and Index.

"Each species account includes, the local name(s), the geographical distribution and density (distribution map shows each species' geographical range), a botanical description, highlighting distinguishing features, comparisons with other similar palms, habitat preference, pollinators and distributors, economic uses and conservation statues." Twenty-two species of palms are recognized, discussed in detail and photographed in their natural habitat.

A NEW SPECIES OF *BRAZORIA* (LAMIACEAE) FROM THE CENTRAL MINERAL REGION OF TEXAS

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ABSTRACT

Brazoria enquistii M.W. Turner sp. nov. from the central mineral region of Texas (Mason, Llano and Burnet counties) is described. It is similar to *B. truncata* (Benth.) Engelm. & A. Gray from which it differs in having longer floral bracts with more pronounced ciliation, shorter internodes, and distinctions in the lobes of the calyx. Its habitat and edaphic preferences, unique to the genus, are also discussed. Descriptions, photographs, dot-maps, and keys to species are presented.

RESUMEN

Se describe *Brazoria enquistii* M.W. Turner sp. nov. de la región mineral central de Texas (condados de Mason, Llano y Burnet). Se asemeja a *B. truncata* (Benth.) Engelm. & A. Gray de la que se distingue por tener las brácteas florales más largas con ciliación más destacada, los entrenudos más cortos, y unas distinciones en los lóbulos del cáliz. Su hábitat y preferencias edáficas, únicos en el género, también se discuten. Se ofrecen descripciones, fotos, mapas de distribución, y clave de especies.

As noted previously in my overview of the genus (Turner 1996), the only three collections of *Brazoria* that were known to me from the central mineral region of Texas prior to 1996 (from collections housed at BRIT, GH, K, LL, OKL, TAES, TEX) possibly constituted an undescribed taxon, but lack of extant populations precluded their recognition. Subsequently, sightings of populations of the taxon by Marshall Enquist in this region prompted three years of additional fieldwork by myself. These studies have convinced me that the plant is undescribed and is deserving of specific recognition.

TAXONOMY

Brazoria enquistii M.W. Turner, sp. nov. (**Figs. 1, 2** & **3**). TYPE: U.S.A. TEXAS: Mason Co.: ca. 11 airline mi ESE of Mason, off Lower Willow Creek Rd at crossing of Willow Creek, 4 mi E of US Hwy 87, 11 May 1996, *M.W. Turner 64* (HOLOTYPE: TEX; ISOTYPES: BRIT, GH, MO, TAES, US).

Brazoriae truncatae (Benth.) Engelm. & A. Gray var. *truncatae* similis sed racemis compactissimis cum internodis 2.5–4.0 m; bracteis floralibus 8–12 mm, cum ciliis 2 - 3 mm; lobis inferioribus calycum leniter apiculatis, plerumque habentibus unum "dentem" per lobum. Plantae indescriptae conservandae sunt.

Erect annual herbs mostly 15–40 cm high, simple, or branched at base; if latter, branches immediately ascending from base. **Stems** square, pubescent below

inflorescence on all sides. **Leaves** opposite; lower leaves, if persistent, usually oblanceolate (occasionally spatulate), 5–9 cm long, 1–2 cm wide, often tapering to a long-winged petiole; margins undulate to denticulate; upper leaves oblong to elliptic, denticulate, usually sessile and partly clasping. Mature **spikes** racemoid, densely flowered, with lower internodes mostly 2.5–4.0 mm long; flowers decussate. **Bracts** at base of pedicels mostly ovate-orbicular, 8–12 mm long; margins ciliate, with hairs mostly 2–3 mm in length. **Calyces** broadly campanulate, 5–8(–10) mm long, bilabiate; the two lower lobes mostly truncate with one "tooth," woolly-tomentose at base, with many eglandular hairs reaching 2 mm in length; upper middle lobe usually truncate or shallowly mucronate; upper lateral lobes mucronate to apiculate; capitate-glandular hairs scattered over both lower and upper lobes. **Corollas** 15–25 mm long, bilabiate, pale lavender and usually distinctly veined, sparsely puberulent along the upper surface; upper lip bifid; lower lip trifid, lobes usually emarginate; throats with annulus usually perpendicular to axis of corolla 2–3 mm above ovary, maculate, with distinct hump on lower surface beneath stamens. **Stamens** 4, fertile, the anterior pair longer than the posterior. **Filaments** ca. 1 mm wide at base of free portion, conspicuously winged, villous, arched inward near apices; upper pair free from adnation to corolla for 3–4 mm; lower, innermost pair free for 1.0–1.5 mm, with mutually opposing "bulges" or "shoulders" that, together with overlapping hairs, hold style in epipetalous position. **Thecae** apiculate laterally at base, dark purple and ringed with white; upper pair slightly smaller than lower (ca. 1.2 mm vs 2.0 mm); ventral (rarely dorsal) surface of connective tissue between thecae usually with several to many white hairs. **Styles** 1.0–1.5 mm long, bilobed, glabrous; branches linear-lanceolate. **Nutlets** mostly 1.5–2.5(–3.5) mm long, strongly trigonal, with incurved hispidulous hairs, rarely glabrous.

Distribution.—The most geographically isolated species of the genus, *Brazoria enquistii* is known only from three counties—Burnet, Llano, and Mason (**Fig. 1**)—and I have only been able to locate extant populations in the latter two of these. Many attempts to ascertain distribution extensions (beyond what is reported here) have been made in the surrounding vicinity over the past five years to no avail. Although only ca. 130 km separates the taxon (Llano/Burnet Co. border area) from the nearest populations of *B. truncata* (Bastrop Co.) (**Fig. 2**), the intervening distance presents the sand-loving genus with a barrier of limestone, the central mineral region being renowned as a granitic outcrop (which weathers to sand) surrounded by calcareous soils. This geographic isolation, together with its infrequent occurrence and short blooming period, have kept the taxon in relative obscurity.

Habitat.—*Brazoria enquistii*, unlike the eastern species of the genus which tend to prefer the loose white sands of xeric slopes, grows almost exclusively along granitic streambeds of the Llano River watershed. Only four of the 16 populations discovered by the author (sites of *Turner 71, 72, 95* and *96*) are not

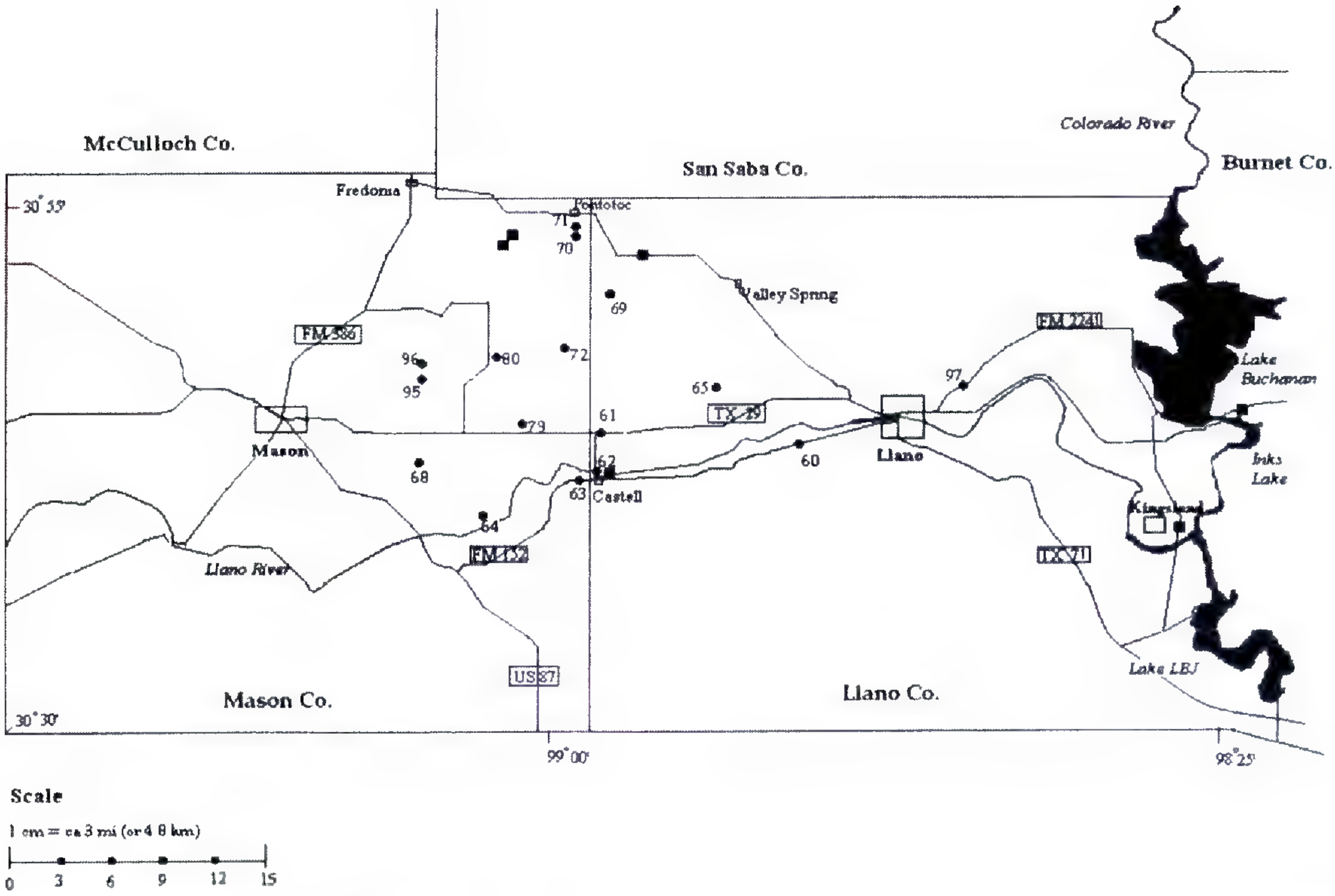


FIG. 1. Documented distribution of *Brazoria enquistii* in three counties of central Texas. Closed circles represent specimens collected by author; numbers refer to collection numbers cited. Closed squares represent other documented collections known to date and cited herein.

along such streambeds (but even two of these are within 100 m of one). More specifically, the species is rarely found near the water's edge, but rather occurs on the raised, sparsely-vegetated sand embankments within 10–20 m of adjacent streams. The species seems to prefer embankments along permanent water, and is only rarely found in dry washes and gullies. One of the largest populations (estimated at 10,000+ individuals at the type locality) was discovered on a large, flat, sand island in the middle of Willow Creek as it approaches the Llano River. Indeed, the species seems to flourish in creek beds as they widen downstream near their mouths (presumably because the waterways accumulate more sand), and becomes less abundant upstream as the creeks become narrower. Only three of the 22 sites known to date (both historical and extant) lie south of the Llano River.

Phenology.—All known collections are from the month of May.

Remarks.—*Brazoria enquistii* most closely resembles *B. truncata* var. *truncata*. The most obvious distinguishing character of the taxon is its long and well-developed bracts (see Fig. 3 and key following), which almost conceal the developing buds, in stark contrast to the shorter bracts of *B. truncata* whose buds, left exposed to view, display themselves in the compact rows that have earned that species the common name of "rattlesnake flower." Another obvious character is the internode length which is the smallest of the genus (2–4

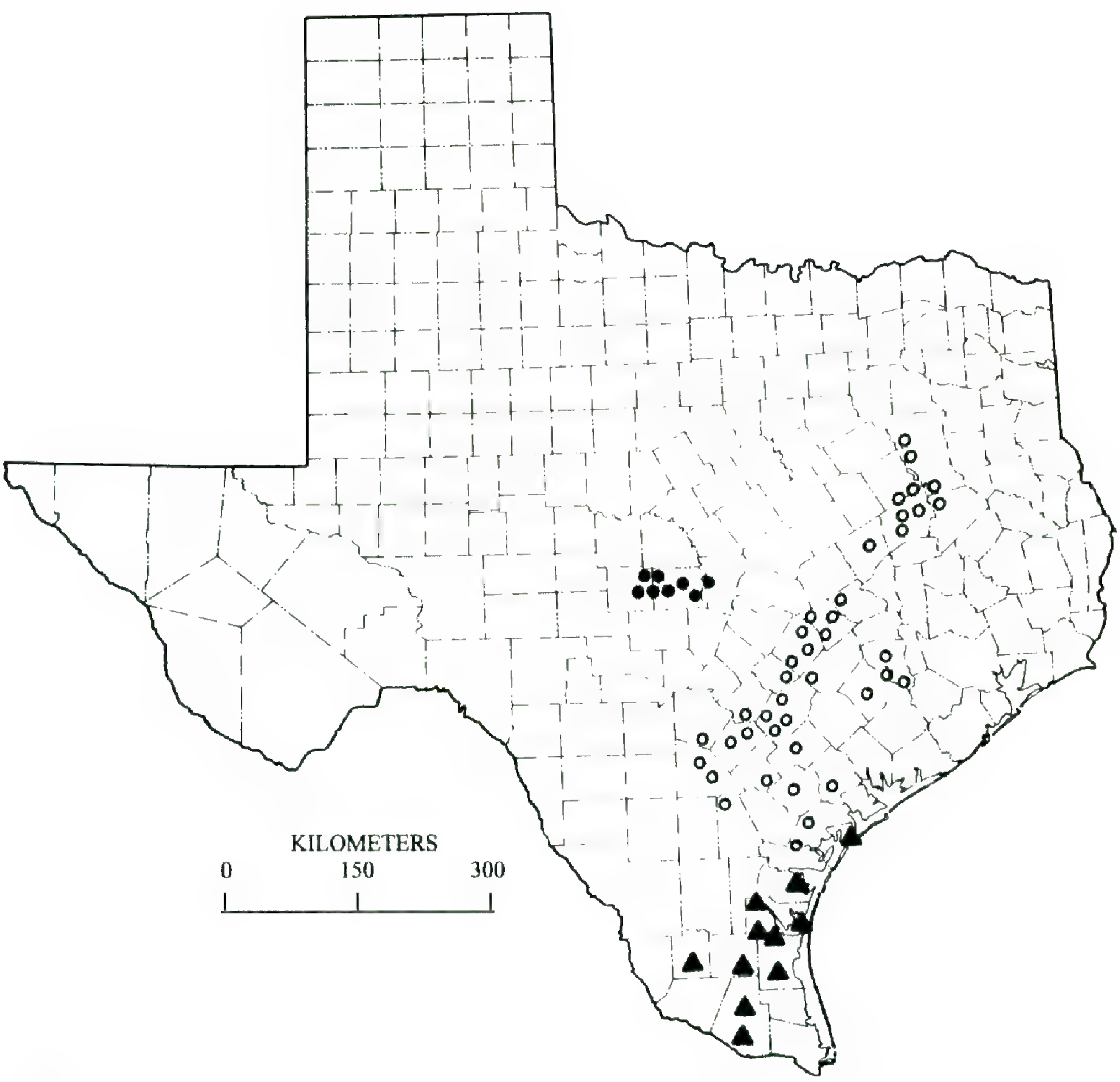


Fig. 2. Distribution of *Brazoria* species (varieties not shown). *B. arenaria* (closed triangles); *B. truncata* (open circles); *B. enquistii* (closed circles).

mm vs. 5–6 mm for *B. truncata* var. *truncata*, 8–13 mm for *B. t.* var. *pulcherrima* (Lundell) M.W. Turner, and 8–20(–30) for *B. arenaria* Lundell) and provides for an extremely compact spike.

Less obvious characters distinguishing the taxon from *B. truncata* include a longer bract ciliation (2–3 mm vs. 1–2 mm), a distinct shape to the lower lobes of the calyx (truncate or with only 1 "tooth" vs. with 3–5 "teeth"), and a subtle difference in the shape of the upper middle lobe of the calyx (truncate to shallowly mucronate vs. mucronate to apiculate).

So far as known, the first recorded collection of the taxon was made in 1910 in Kingsland (Llano Co.), *Hastings s.n.* (LL). Some 20 years later, the second recorded collection is from an area six miles northwest of Valley Spring in Llano Co., *Bauman's* [sic] *6286* (TAES). Some 30 years elapsed before the third collection was made (in 1962 in Inks Lake State Park, Burnet Co., along Clear Creek,





FIG. 3. Three comparative stages of inflorescence development in two species of *Brazoria*. Top row, **A–C:** *Brazoria enquistii*. **A,** budding inflorescence with long floral bracts (lower bracts here at the upper limit of bract range, ca. 12 mm); **B,** early stages of flowering, bracts subtending the buds; **C,** mature flower with tightly compressed calyces due to short internodes. Bottom row, **D–F:** *Brazoria truncata* var. *truncata*. **D,** short floral bracts hidden (cf. "rattlesnake flower," the common name for this species); **E,** bracts do not (or rarely) subtend buds; **F,** internodes longer, calyces not compressed.

Correll & Ogden 25300 (LL)). An extant population has been found at a location approximating the second collection (*Turner 69*); however, the author's repeated attempts at locating living populations in the Kingsland area and in western Burnet Co. have been unsuccessful. The Kingsland area may have become overdeveloped and/or the damming of the Colorado River for Lake LBJ (in 1951 with the Alvin Wirtz Dam) may have influenced the habitat. Repeated visits to Inks Lake State Park, with special attention to Clear Creek and Spring Creek, have likewise revealed nothing. A 1996 sighting by Marshall Enquist from the Llano/Burnet Co. line area (near Buchanan Dam), prompted this investigation, but local roadwork, immediately thereafter, completely altered the site and no further sightings have been made in the area to date. At the present, the western edge of Burnet Co. represents the eastern limit for the species.

Brazoria enquistii is the most geographically restricted taxon of the genus, distributed primarily within just two counties. Like *B. truncata* var. *pulcherrima*, which is restricted to about five counties in northeastern Texas (Turner 1996), *B. enquistii* can be locally abundant, which would likely preclude it from endangered species status. On the other hand, it is more infrequent in occurrence, tending to appear in isolated patches (due to its specialized habitat), rather than being loosely scattered along the roadside. The number of individuals at a given location can vary sharply from year to year: the type locality mentioned above contained over 10,000 plants in 1996, but only about 1% of that number in 1999.

Choice of rank.—The taxon is here treated at specific rank for the following reasons: it exhibits several distinguishing morphological characters (outlined above); it has a habitat and edaphic preference distinct from the other taxa of the genus (raised embankments of streambeds in purely granitic sand vs. xeric slopes of loose, white, non-granitic sands in open woodlands and stabilized dunes); it is geographically and edaphically isolated by the surrounding calcareous soil, which erects a barrier to gene exchange; and no populations intermediate to its related taxa have been discovered.

Etymology.—The species is named for Marshall Enquist, an attorney in the Austin area, who called to my attention extant populations in the central mineral region, without which this paper would not have been possible. Mr. Enquist's excellent floristic guide (Enquist 1987), as well as his active research on native Texas flora (including *Anemone*, *Crataegus*, *Desmodium*, and *Prunus*), have been an inspiration to botanists and naturalists alike.

Specimens examined: **U.S.A. Texas. Burnet Co.:** Inks Lake State Park along Clear Creek, 18 May 1962, *Correll & Ogden 25300* (LL). **Llano Co.:** Kingsland, 12 May 1910, *Hastings s.n.* (LL); 6 mi NW of Valley Spring, 8 May 1933, *Bauman's* [sic] *6286* (TAES); ca. 6 mi WSW of Llano on FM 152 at Six Mile Creek, 11 May 1996, *Turner 60* (TEX); ca. 18 mi due W of Llano on TX 29 in Weide Creek, 14 May 1996, *Turner 61* (TEX); Castell, 19 May 1991, *Enquist 1934* (TEX); In Castell at Llano River crossing on FM 2768, 14 May 1996, *Turner 62* (TEX); ca. 6 airline mi due W of Valley Spring, on CR 405, 2.1 mi S of TX 71 at San

Fernando Creek crossing, 18 May 1997, *Turner 69* (TEX); ca. 2.5 mi E of Llano, on FM 2241, 1.5 mi NE of jct TX 29, along Wrights Creek, 16 May 1999, *Turner & Robbins 97* (TEX). **Mason Co.:** ca. 0.5 mi W of Castell on TX 152 in creek bed, 14 May 1996, *Turner 63* (TEX); ca. 11 airline mi W of Llano, off CR 404 at San Fernando Creek crossing, 19 May 1996, *Turner 65* (TEX); ca. 7 airline mi ESE of Mason, off Art Hedwigs Hill Rd, 3 mi N of US Hwy 87 & 1.6 mi S of TX 29 along Willow Creek, 18 May 1997, *Turner 68* (TEX); 2.7 mi S of Pontotoc (jct TX 71) on Hickory Grove Rd, along San Fernando Creek, 18 May 1997, *Turner 70* (TEX); 2.2 mi S of Pontotoc (jct TX 71) on Hickory Grove Rd, 18 May 1997, *Turner 71* (TEX); Hillis Fly Gap Ranch, 2.5 mi W of Pontotoc on TX 71, then 3.1 mi S on Fly Gap Rd, then 0.2 mi W to entrance, 12 May 2002, *Hillis 286* (TEX); 2.0 mi S of TX 71 on Fly Gap Rd at creek crossing, 18 May 2002, *Hillis 293* (TEX); ca. 14 airline mi ENE of Mason on Hickory Grove Rd, 2.5 mi N of jct with Union Rd, 18 May 1997, *Turner 72* (TEX); ca. 12 mi due E of Mason on Union Rd, 0.6 mi N of TX 29 at crossing of Martin Creek, 10 May 1998, *Turner 79* (TEX); ca. 11 airline mi ENE of Mason, on Eaton Cemetery Rd, 1 mi E of FM 1900 at crossing of Martin Creek, 10 May 1998, *Turner 80* (TEX); ca. 8 mi ENE Mason, on N Art Rd, 2.4 mi N of jct TX 29, 75 m N of creek (branch of E Willow Creek), 16 May 1999, *Turner & Robbins 95* (TEX); ca. 8 mi ENE Mason, on N Art Rd, 2.8 mi N of jct TX 29, 16 May 1999, *Turner & Robbins 96* (TEX).

A REVISED KEY TO THE SPECIES OF *BRAZORIA*

1. Floral bracts ciliolate, with hairs 0.1–0.2 mm in length; mature plants often basally branched with branches recumbant at base; basal leaves usually persistent, oblanceolate to spatulate; southern Texas ____ **B. arenaria**
1. Floral bracts ciliate, with hairs 1–3 mm in length; mature plants often not basally branched, or, if so, with branches immediately ascending from base; basal leaves rarely persistent, usually oblong to oblong-oblanceolate; central, and southcentral to northeastern Texas.
   2. Floral bracts at base of pedicels mostly 8 12 mm in length; mature spikes very densely flowered, with lower internodes mostly 2.5–4.0 mm long; lower lobes of calyces shallowly apiculate with mostly one "tooth" per lobe; central mineral region (Burnet, Llano, Mason Co.) ____ **B. enquistii**
   2. Floral bracts at base of pedicels mostly 4–8(–9) mm in length; mature spikes less densely flowered, with lower internodes mostly 5–13 mm long; lower lobes of calyces dentate with mostly 3–5 "teeth" per lobe; not in central mineral region ____ **B. truncata**

ACKNOWLEDGMENTS

I am grateful to the Directors and Curators of the following institutions for the loan of approximately 450 herbarium specimens: BRIT, GH, K, LL, OKL, TAES, TEX. I would also like to thank Gayle Turner for assistance with the Latin diagnosis, David Hillis for bringing to my attention additional locations of *B. enquistii* near his ranch, and Tom Wendt and Lindsay Woodruff for the use of the Plant Resources Center (TEX-LL) and for the steadfast care and kindness that they have extended to me in answering my many questions.

REFERENCES

ENQUIST, M. 1987. Wildflowers of the Texas hill country. Lone Star Botanical, Austin, TX.

TURNER, M.W. 1996. Systematic study of the genus *Brazoria* (Lamiaceae), and *Warnockia* (Lamiaceae), a new genus from Texas. Pl. Syst. Evol. 203:65-82.

BOOK NOTICES

Systematics/Monographs/Floras/Guides

CHRISTOPHER NEWSHOLME. 1992 (Paper back reprint 2003). **Willows: The Genus *Salix*.** (ISBN 0-88192-565-9, pbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $19.95, 256 pp., 65 color photos, numerous line drawings, 6 × 9".

Contents.—Color Illustrations, Acknowledgments, Preface, Introduction, General Characteristics of Willows, Management and Cultivation, Ornamental Trees and Shrubs for Large Gardens, Parks and Estates, Ornamental Trees and Shrubs for Small Gardens, Dwarf and Ground-hugging Alpine Species for Rock Gardens, Glossary, Bibliography, General Index, and Botanical Index.

IAN HALL, STEVEN STEPHENSON, PETER BUCHANAN, WANG YUN, and ANTHONY COLE. 2003. **Edible and Poisonous Mushrooms of the World.** (ISBN 0-88192-586-1, hbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $39.95, 372 pp., 253 color photos, 6 color illustrations, 3 tables, 6 × 9".

This valuable book includes detailed descriptions, keys to help identify many common and important mushrooms, edible and not so edible. The authors offer suggestions and instructions on critical identification, mushroom toxins and guidelines to follow when mushroom hunting. The excellent photographs are sharp and colorful.

SANDRA KNAPP. 2003. ***Solanum* Section *Geminata* (Solanaceae).** (ISBN 0-89327-441-0, pbk.). Flora Neotropica Vol. 84. The New York Botanical Garden Press, 200th Street & Kazimiroff Boulevard, Bronx, NY 10458-5126, U.S.A. (Orders: 718-817-8721, 718-817-5126 fax, http://www.nybg.org, nybgpress@nybg.org). $60.00, 404 pp., 204 figs. (b/w photos, line drawings, maps), 7 × 10".

Contents.—Abstract/Resumen, Introduction, History of Classification of *Solanum*, Nomenclatural and Taxonomic History of Section *Geminata*, Morphology, Ecology and Natural History, Species Groups and Species Concepts, Taxonomic Treatment, Doubtful Names, Excluded Names, Acknowledgments, Literature Cited, Numerical List of Taxa, Exsiccatae, Index to Scientific Names, and Appendices.

"The 126 species plus four insufficiently known taxa are discussed in context with their putative relationships." Each taxonomic entry includes nomenclature, synonyms, description, chromosome number (if known), illustration (line drawing/b/w photo), distribution (map included), selected specimens examined, local names (if applicable) and general comments on relationships to other taxa, morphology and natural history. This is a major accomplishment for the *Flora Neotropica* series

TWO NEW SPECIES OF *LIATRIS* SERIES *GRAMINIFOLIAE* (ASTERACEAE: EUPATORIEAE) FROM THE SOUTHEASTERN UNITED STATES

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ABSTRACT

Two species of *Liatris* series *Graminifoliae* are described for the first time and illustrations and distribution maps are provided for both. **Liatris savannensis** Kral & Nesom, sp. nov., is similar to *L. graminifolia* but differs in its larger heads with more numerous florets and broader, erose-lacerate phyllary margins. It occurs on the western coast of peninsular Florida, south of the known range of *L. graminifolia*. **Liatris patens** Nesom & Kral, sp. nov., is similar to *L. gracilis* in its consistently pedunculate heads and hirtellous-strigose stems and peduncles but differs in longer peduncles and larger heads with more numerous florets; it is similar to *L. graminifolia* in head size and number of florets but differs in its hairy stems and peduncles and longer peduncles. *Liatris patens* occurs in southeastern Georgia and adjacent South Carolina, where it apparently is allopatric in range with its close relatives *L. graminifolia* and *L. gracilis*.

RESUMEN

Se describen por primera vez dos especies de *Liatris* serie *Graminifoliae* y se aportan ilustraciones y mapas de distribución para ambas. **Liatris savannensis** Kral & Nesom, sp. nov., es similar a *L. graminifolia* pero se diferencia por sus cabezuelas más grandes con flósculos más numerosos y márgenes de los filarios más anchos y lacerados. Aparece en la costa oeste de la península de Florida, al sur del área conocida de *L. graminifolia*. **Liatris patens** Nesom & Kral, sp. nov., es similar a *L. gracilis* por sus cabezuelas pedunculadas, y tallos y pedúnculos hirto-estrigosos pero se diferencia por tener pedúnculos más largos y cabezuelas más grandes con muchos más flósculos; es similar a *L. graminifolia* por el tamaño de las cabezuelas y número de flósculos pero se diferencia por sus tallos pelosos, y pedúnculos pelosos y más largos. *Liatris patens* aparece en el sureste de Georgia y parte adyacente de Carolina del Sur, donde aparentemente es alopátrica con sus parientes cercanos *L. graminifolia* y *L. gracilis*.

The species of *Liatris* series *Graminifoliae* (Gaiser 1946) are characterized by a pappus of barbellate bristles, corolla tubes pilose within, phyllaries nearly flat to rounded, obtuse, or acute at the apex, and sessile or pedunculate heads with 3–17(–20) florets. Gaiser recognized five species in series *Graminifoliae*: *L. graminifolia* Willd., *L. helleri* Porter, *L. gracilis* Pursh, *L. regimontis* (Small) K. Schum., and *L. turgida* Gaiser. Stucky (1991, 1992) and Stucky and Pyne (1990) recently clarified concepts related to several related taxa, reviving use of the name *L. virgata* Nutt. (to include *L. regimontis* and *L. graminifolia* var. *smallii* (Britt.) Fern. & Grisc.), and adding *L. cokeri* Pyne & Stucky to the group. *Liatris gholsonii* L. Anderson, an endemic of the Apalachicola River bluff system in

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the Florida panhandle and close relative of *L. gracilis*, was recently described (Anderson 2002). The present study adds two more species to this group—the first endemic to a small region on the western coast of peninsular Florida, the second known from a broader area of southeastern Georgia.

In the fall of 1964, during a field study of slash pine-sabal palmetto savanna adjacent to brackish marshland in the vicinity of Punta Gorda, Florida, the first author collected an unusual *Liatris*. Additional collections were made from other sites in two adjacent counties over the course of the next 15 years, but a final determination of its identity was not made and other work intervened. After 40 years, its description is presented here.

Liatris savannensis Kral & Nesom, sp. nov. (**Fig. 1, 3**). TYPE: UNITED STATES. FLORIDA. Charlotte Co.: wet pine/cabbage palm flats, ca. 3 mi S of Punta Gorda, 7 Oct 1979, *R. Kral 64559* (HOLOTYPE: US; ISOTYPES: FSU, NY, VDB, VSC).

Liatri graminifoliae similis, sed capitulis majoribus flosculis numerosioribus et phyllariis marginibus latioribus erosi-laceratis differt; *L. spicatae* similis sed differt caulibus glandulosis, foliis manifeste punctatis marginibus ciliatis, et tubis corollarum interne pilosis.

Plants perennials, corms ranging from globose to irregularly cylindric, narrowly ovoid, or fusiform and caudex-like. Stems stiffly erect, (80–)90–130 cm tall, simple or (rarely) ascending-branched, terete, irregularly multicostate and shallowly grooved, glabrous but (including inflorescence axis) often sparsely but evidently sessile-glandular. Leaves in high spiral, the oldest approximate, mostly broken away by anthesis, but, if present, elongate (–30 cm), essentially narrowly linear-lorate, those immediately above on stout internodes to 5 cm or more, pandurate, gladiate-lorate, (17–)20–40 cm long, with broad, clasping-based, intermittently pilose-ciliate petiole bases, gradually narrowed, then dilating to linear-elliptic, linear-spatulate or linear oblanceolate blades 3–10 mm wide, the petiolar nerves convergent to few laterals (ultimately no laterals), the median nerve broad, sulcate or compound, apex variously acute, callused, margin entire, slightly thickened, surfaces pale green with darker glandular punctation, glabrous except for some intermittent pilosity along abaxial midrib; upstem leaves gradually shortening, narrowing in tighter spiral, sessile, mostly ascending, proximally pilose-ciliate, transitional to inflorescence bracts, the lowermost exceeding, the uppermost exceeded by, heads. Inflorescence mostly determinate, spiciform, rarely branched, its axis typically at least as long as the leafy part of the plant, the heads sessile or on peduncles mostly 1–2 mm long. Heads spreading-ascending, turbinate-campanulate; involucre just past anthesis (7–)8–10 mm high from base to involucral apex, (8–)9–11(–12) mm wide (pressed); phyllaries ciliate, in (3–)4(–5) series, the lowermost shortest, 1.5–3 mm, ovate to oblong, fleshiest, greenish, glandular-punctate, 3-nerved, progressively longer inward, 4–6 mm, becoming obovate, then spatulate 7–9(–10) mm, apically broadly rounded, with a hyaline, pinkish-purple, erose to lacerate bor-

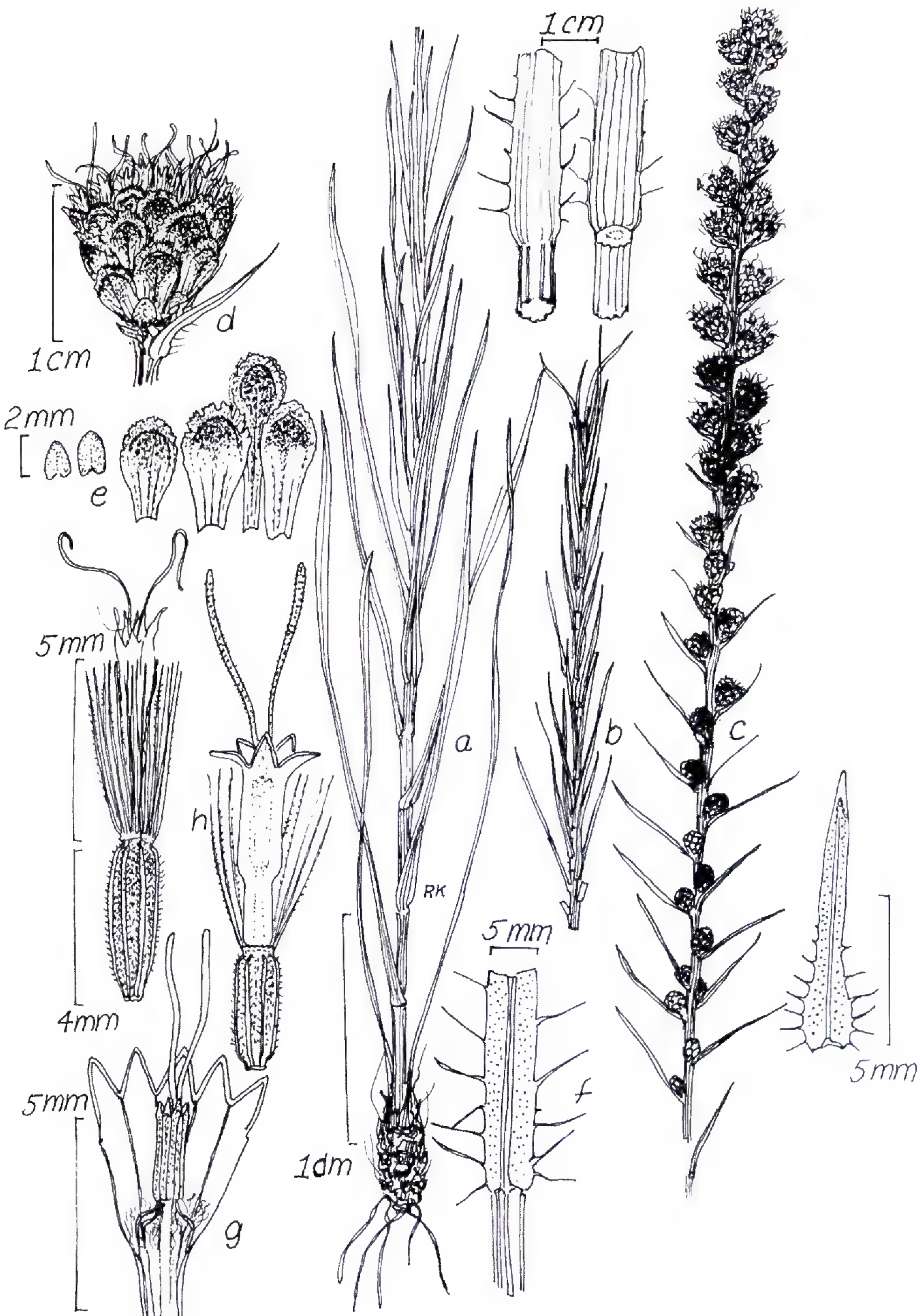


FIG. 1. *Liatris savannensis* (from the type). **a.** Habit, lower stem (at left); lower leaf base, abaxial (left) and adaxial (right) view. **b.** Midstem. **c.** Inflorescence (left), subtending bract, abaxial view (right). **d.** Head, with subtending bract. **e.** Phyllaries of a series from lowermost (left) to inner/uppermost (right). **f.** Base of midcauline leaf, abaxial side. **g.** Adaxial view of spread corolla. **h.** Fertilized floret (left); floret at anthesis (right).

der (0.2–)0.4–1 mm wide, intermittently ciliolate, the dorsal areas of longer bracts greenish to reddish-green or purple, distinctly glandular-punctate, with a sharp, low, rounded buttress delimiting the hyaline border. Florets 9–16(–17); corolla tubes at anthesis yellowish or pale with pinkish-purple lobes, sessile-glandular, tubular portion 5 mm, lobes 5, spreading, triangular, 2 mm long; internally pilose in the region of filament insertion with a broad annulus of whitish, crisped hairs. Achenes cylindric, base slightly narrowed, apex with a short neck at juncture with pappus rim, ca. 4 mm long, blackish, with ca. 10, paler, raised ribs, densely hirtellous on the ribs, sparsely so on the intervals; pappus mostly 5 mm long, bristles 30–40, pale purple-brown distally, strongly barbellate.

Etymology and habitat.—The epithet "savannensis" alludes to the savanna habitat of the species. The habitats are characterized as open sandy flats, usually moist or wet sites, dominated by slash pine, sabal palmetto, or a mixture of the two. Collections of flowering plants have been made mostly from mid-September through mid-October. Flowering less commonly may begin in August and extend into November.

Additional collections examined. **UNITED STATES. FLORIDA. Charlotte Co.:** S side of Punta Gorda on sandy peat of slash pine flatwoods bordering brackish marsh, 21 Sep 1964, *Kral 22919* (VDB, 2 duplicates distributed as *L. spicata*); sandy palmland by brackish marsh, E side of Punta Gorda, 21 Sep 1973, *Kral 51978* (FLAS, GH, MO, TEX, VDB); wet grassy clearings in pine palmetto flats by US Hwy 41, 1 mi S of Punta Gorda, 7 Oct 1979, *Kral 64561* (FSU, GH, MICH, MO, NY, TEX, VDB); abundant in marshy lands, each side of RR tracks, within city limits, S side of Punta Gorda, 29 Sep 1961, *Lakela 24684* (BRIT, FLAS, USF). **Hillsborough Co.:** Hillsborough River State Park, 20 mi NE of Tampa on US 301, 18 Oct 1977, *Arcuri 587* (USF); along Fla. Hwy 581, ca. 5 mi N of Tampa, roadside, 6 Oct 1977, *Funk 48* (USF); along SR 581, ca. 5 mi N of Tampa, 6 Oct 1977, *Gregory 18* (USF), margin of flat, open pineland with scattered palmetto, N of Tampa Air Port, Kennedy Road, 13 Sep 1961, *Lakela 24637* (USF); flat pinelands and palmetto, and along boulevards NW of International Airport, Tampa, 24 Sep 1961, *Lakela 24670* (BRIT); margin of pineland and palmetto, along US 301, ca. 1 mi S of Hillsborough River State Park, NE of Tampa, 1 Oct 1963, *Lakela 26508* (FLAS, USF); frequent along SR-581, ca 5 mi N of Tampa, 6 Oct 1977, *Lindsey 30* (USF); Rocky Creek, disturbed site near Rocky Creek and Memorial Hwy, 7 Oct 1977, *Mortellaro and Giesy 169* (USF); disturbed area at edge of oak woodland along SR-581, ca. 5 mi N of Tampa, 6 Oct 1977, *Willett 32* (USF); flat ground edge of pine flatwoods, 5 mi N of Fletcher Avenue on 30th Street, Tampa, [Oct 1977], *Winkler 36* (USF); Flatwoods Park, 2.5 mi NW of Morris Bridge, ca. 7 mi E of Lutz, pine flatwoods, 22 Oct 1994, *Wunderlin 10618* (USF). **Lee Co.:** Business Rte. 41, N of Ft. Myers, in front of public library, pine woods, 7 Nov 1985, *Brown s.n.* (USF); [no specific locality], 1 Aug 1933, *Buswell s.n.* (USF). **Manatee Co.:** Bradenton, dry sand hills, Palma Sola, 19 Aug 1945, *Gaiser, Butts, and Arnold s.n.* (FLAS). **Sarasota Co.:** T. Mabry Carlton, Jr. Memorial Reserve, pine flatwoods between wet prairies, grassy area surrounded by saw palmetto, 13 Oct 1997, *Edmondson 97-34* (USF); T. Mabry Carlton, Jr. Memorial Reserve, disturbed edge parallel to So. FPL grade, 13 Oct 1997, *Edmondson 97-35* (USF); sandy peat of open pine-palm hammock at N side of Engelwood, 7 Oct 1979, *Kral 64571* (4 duplicates, to be distributed); sandy embankments marginal to flat pinelands, 10 mi S of Venice, US 41, with *Monarda*, *Coreopsis*, and *Rhus copallina*, 20 Sep 1961, *Lakela 24648* (FLAS, USF).

Two species of series *Graminifoliae* grow in the general area of *Liatris savannensis*. *Liatris gracilis* occurs throughout Florida but grows in distinctly

drier, sandier, more upland ecological systems; it differs from *L. savannensis* in its hairy stems and peduncles, smaller, consistently short-pedunculate heads, fewer florets per head (3–6(–7)), and shorter achenes. *Liatris graminifolia* is more similar to *L. savannensis* in vestiture and head size, but the geographic range of *L. graminifolia* apparently extends southward only to the vicinity of Levy County, apparently separated by roughly 150 kilometers from the nearest known population of *L. savannensis* in Hillsborough County.

Liatris savannensis closely resembles *L. spicata* (L.) Willd., which occurs throughout Florida, and has commonly been identified as such. The two are similar in their tall stems, narrow leaves, essentially glabrous vestiture, similar-sized heads in a spicate inflorescence, and phyllaries often with a broad, scarious, pinkish rim. The first author identified his initial collections as *L. spicata*, but in 1968, going back to the material and (finally!) opening a corolla, noted pilosity within it, an annulus of crisped hairs at the level of the filament bases. We follow Gaiser (1946) in weighting the presence of this pilosity as an indicator of relationship (Nesom in prep.), with the implication that *L. savannensis* is a member of series *Graminifoliae*, and observe that similarities between *L. savannensis* and *L. graminifolia* also are strong.

The following pair of couplets outline significant morphological differences first between *Liatris savannensis* and *L. spicata* and then between *L. savannensis* and *L. graminifolia*.

couplet 1:

1. Stems minutely sessile-glandular; leaves prominently punctate, proximal margins sparsely but distinctly ciliate with hairs 1–2.5 mm long; corolla tubes pilose within at the region of filament insertion; florets 9–16(–17) per head. _____ **Liatris savannensis**
1. Stems eglandular; leaves not punctate or if so, then inconspicuously, margins eciliate or with a few scattered hairs 0.3–0.8 mm long; corolla tubes glabrous within; florets (5–)6–10(–14) per head. _____ **Liatris spicata**

couplet 2:

1. Stems minutely sessile-glandular; involucres (7–)8–10 mm high, (8–)9–11(–12) mm wide; inner phyllaries spatulate, 3.5–4 mm wide, hyaline, distinctly erose to lacerate borders (0.2–)0.4–1 mm wide; florets 9–17 per head; achenes 4–4.5 mm long. _____ **Liatris savannensis**
1. Stems eglandular; involucres 6–8(–9) mm high, 6–7.5 mm wide; inner phyllaries oblong to obovate or slightly spatulate, 1–2.2 mm wide, with hyaline, relatively smooth edged borders 0.1–0.3 mm wide; florets 6–10 per head; achenes 3–4 mm long. _____ **Liatris graminifolia**

Other differences exist between *Liatris savannensis* and *L. graminifolia* where comparisons are less diagnostic. Stems of *L. savannensis* range taller and leaves are longer. Corms of *L. savannensis* range from globose to elongate; we have observed only globose corms in *L. graminifolia*. The basal and lower cauline leaves of *L. savannensis* are essentially strap-shaped (lorate), usually with little increase in width distally, while similar leaves of *L. graminifolia* almost always

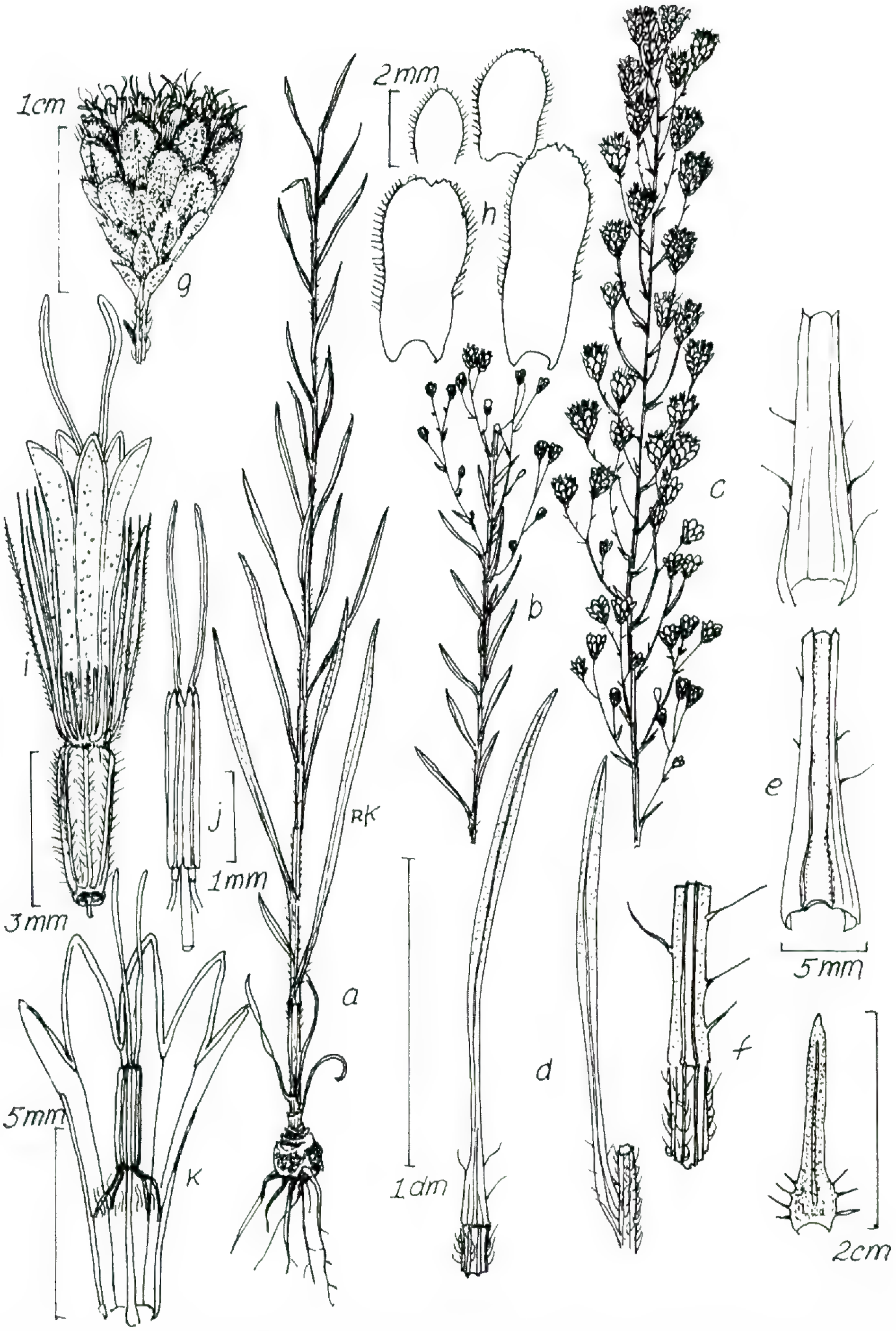


FIG. 2. *Liatris patens* (from *Kral 56936*). **a.** Habit, rootstock and lower half of plant. **b.** Upper leafy part of stem and inflorescence base. **c.** Middle and upper part of inflorescence. **d.** Basal leaf, abaxial view (left), adaxial view (right). **e.** Base of a basal leaf, abaxial side (below), adaxial side (above). **f.** Base of median cauline leaf, abaxial side (left), a lower bracteal leaf (right). **g.** Head in anthesis. **i.** A recently fertilized floret. **j.** Anther tube with exserted style branches. **k.** A spread mature corolla, inside view.

show a distinct petiolar portion in the lower 1/4–1/2 of the total leaf length, distinctly widening into a 'blade' portion. Heads of *L. savannensis* are consistently sessile or on shorter peduncles (peduncles 0–2 mm long) compared to slightly longer ones, on average, in *L. graminifolia* (peduncles 0–3(–7) mm long). In addition to differences in overall phyllary size and margin, the medial, green, glandular-punctate portion of *L. savannensis* phyllaries is consistently raised above the hyaline border by a low, rounded ledge similar to that commonly seen in the large heads of *L. scariosa* (L.) Willd., which is perhaps closely related to ser. *Graminifoliae*.

Liatris graminifolia occurs over a wide area and in various habitats (especially northward), but meaningful infraspecific taxa are difficult to recognize, and comparisons to it in the present study refer to the species as a whole. Southern elements of *L. graminifolia* have phyllaries that are distinctly obovate to subspatulate, similar to those of *L. savannensis*, in contrast to oblong phyllaries, which are characteristic of plants from the northern part of the range of the species (roughly South Carolina and northward, see Fig. 3). The southern plants have been recognized as *L. graminifolia* var. *elegantula* (Greene) K. Schum. (the type from Alabama), but intergradation in phyllary morphology occurs over a wide area and oblong phyllaries are found even in some southern populations. Some descriptions of *L. graminifolia* have attributed more variability in vestiture and floret number to the species than we do, but it seems likely that these descriptions included the two species recognized and segregated for the first time in the present study.

A second previously undescribed species of *Liatris* has been recognized primarily on the basis of herbarium studies connected with preparation of a taxonomic treatment of the genus for the developing Flora of North America (FNA) volumes.

Liatris patens Nesom & Kral, sp. nov. (**Fig. 2, 3**). TYPE: UNITED STATES. GEORGIA. Laurens Co.: drier margins of wet sandy meadow 9 mi E of Dublin, 300 ft elev., 19 Oct 1947, *A. Cronquist 4876* (HOLOTYPE: BRIT).

Liatri graminifoliae similis capitulis comparative grandibus et flosculis numerosis, differt pedunculis longioribus et caulibus ac pedunculis hirtelli-strigosis; *Liatri gracili* similis capitulis consistente peduncularibus et caulibus ac pedunculis pubescentibus, differt pedunculis longioribus et capitulis majoribus flosculis numerosioribus.

Plants perennial, arising from a globose to depressed-globose corm 7–14 mm in diameter. Stems stiffly erect, 35–95 cm tall; stems and peduncles moderately to densely hirtellous-strigose with antrorsely curved, ascending-appressed, multicellular white hairs 0.2–0.4 mm long. Leaves punctate-glandular, glabrous except sparsely ciliate along 1–5 mm of the proximal margins; basal and lower cauline narrowly oblanceolate to linear-oblanceolate, 9–18 cm long, narrowed to a petiolar portion 1/4–1/2 the leaf length, the broader (blade) portion 2–4(–

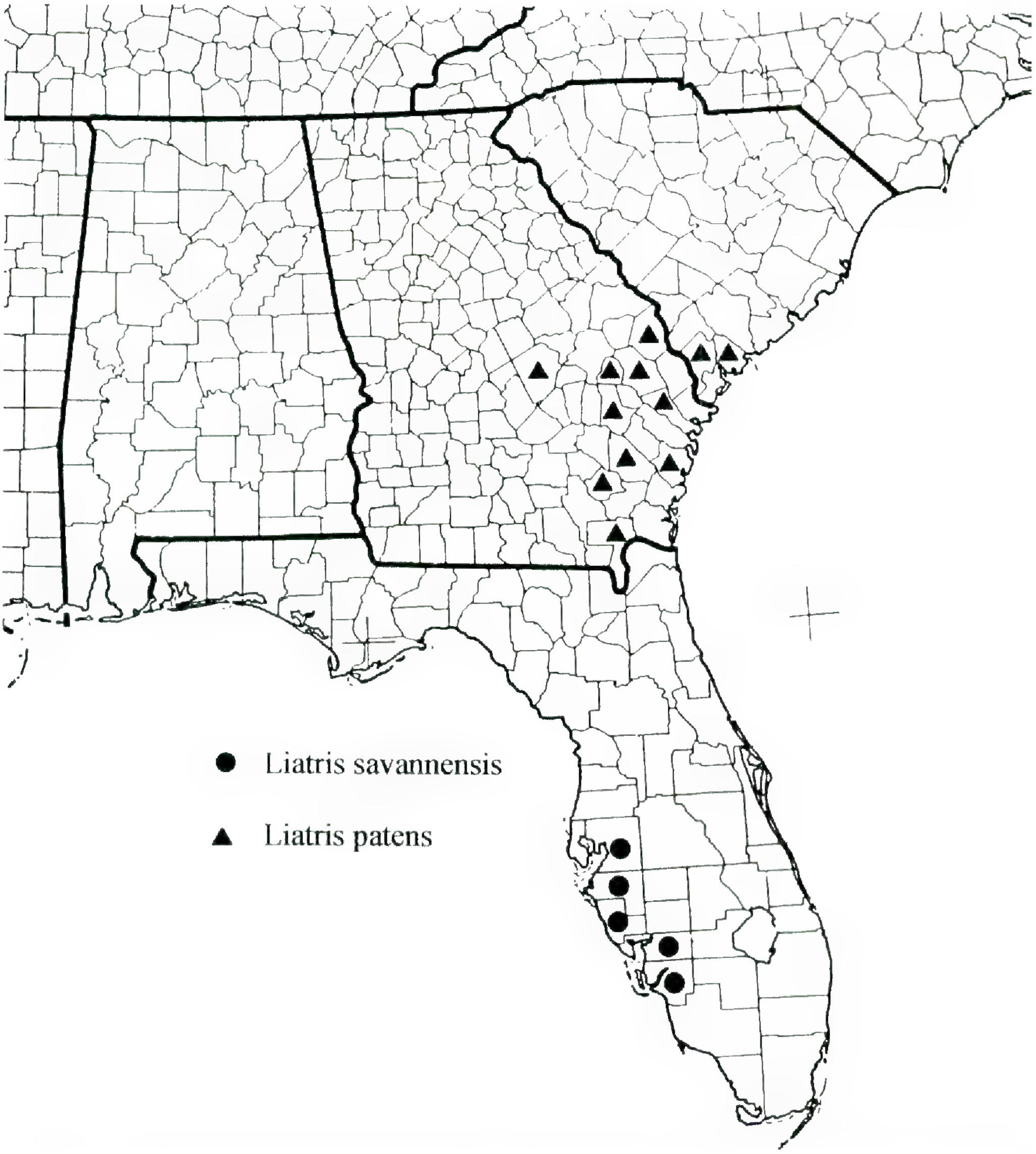


FIG. 3. Geographic distribution of *Liatris savannensis* and *Liatris patens*.

7) mm wide, gradually or abruptly becoming much shorter and linear, upper cauline 1–2 cm long, ca. 0.5 mm wide, grading into inflorescence bracts. Inflorescence racemose, determinate, forming a loose column (10, 20–)25–40 cm long, 3–6 cm wide. Heads erect or nearly so, on divergent-ascending peduncles 1–2.5(–3) cm long, peduncles initially diverging from the inflorescence axis at angles of 45–90 degrees, subtended by a linear bract 5–12 mm long, minutely subulate-bracteate, rarely (especially above damage and mostly on lower peduncles) 1–2-branched; involucres turbinate-campanulate, (5–)6–7.5 mm high, 5–7 mm wide (pressed); phyllaries in (2–)3–4(–5) series, strongly graduate in length, erect,

nearly flat, green with an evident midvein, broadly obovate to broadly oblong-obovate, apex rounded to nearly flat, innermost 1.5–2.5 mm wide, (5–)6–7.5 mm long, outermost mostly ovate, ca. 1/5–1/3 as long as the inner, all evenly punctate-glandular, outer sparsely strigose-villous with white hairs like those on the peduncles, inner glabrous, margins hyaline and pinkish-purple (like the corollas), 0.1–0.3 mm wide, even to slightly erose, usually densely ciliate. Florets 7–12; corollas pinkish-purple, sessile-glandular, tubular portion 4–5(–6) mm long, lobes 5, spreading, narrowly triangular, 2–2.5 mm long; internally pilose in the region of filament insertion with a broad annulus of whitish, crisped hairs. Achenes obtriangular in outline, slightly flattened, with ca. 10 nerves, 2.5–2.8 mm long, densely but weakly hirsute on nerves and intervals; pappus 5–6 mm long, usually equal or longer than the corolla tubes, bristles strongly barbellate, distally purplish.

Etymology and habitat.—The epithet "patens" alludes to the spreading, relatively long peduncles characteristic of the species. Collections have been made in sandy pinelands of southeastern Georgia and adjacent South Carolina, apparently mostly commonly in moist sites. Known collections have been made in late September through November.

Additional collections examined. **UNITED STATES. GEORGIA. Bryan Co.:** Fort Stewart Military Reservation, Training Area C18, N side of Fort Stewart Road 58, ca. 1.8 mi E of jct with Georgia Rte. 67; occasional on disturbed sandhill, 5 m elev., with *Vaccinium myrsinites*, *Quercus geminata*, 25 Sep 1992, *Zebryk 672* (VDB). **Bulloch Co.:** 4.5 mi NW of Portal in open wooded area, 12 Oct 1962, *Boole 1311* (BRIT, TEX, US). **Candler Co.:** sandy longleaf pineland above bog by hiway, ca. 3 mi NW of Aline, 9 Oct 1975, *Kral 56936* (VDB). **Charlton Co.:** plentiful in open disturbed area [along] Ga 177, 13 mi NE of Edith, 8 Oct 1966, *D'Arcy 1223* (VDB). **McIntosh Co.:** sandy flatwoods along US 17, near Middleton Church at Eulonia, 20 Oct 1987, *Angerman s.n.* (USCH); clearcut woods on north side of Eulonia, 20 Oct 1987, *Angerman s.n.* (USCH). **Pierce Co.:** sandy rise in pine flatwoods, 10 mi N of Bristol on Ga. 15, 11 Oct 1991, *Kral 79978* (VDB); sandy pineland by US 301, S side of Jesup by Landmark Motel, 9 Oct 1975, *Kral 59916* (VDB). **Screven Co.:** ca. 2 mi from Blue Springs near a "Carolina Bay," 10 Oct 1959, *Boole 997* (BRIT). **Tattnall Co.:** ca. 5 mi from Tattnall-Bryan County line on Route 280 from Claxton, 17 Oct 1959, *Boole 1018* (BRIT). **Wayne Co.:** sandy peat of pine-palmetto flats, by US 341, 2 mi NW of Everett, 1 Oct 1976, *Kral 59205* (VDB). **SOUTH CAROLINA. Beaufort Co.:** N of Victoria Bluffs Heritage Preserve, near Victoria Bluffs development, N of Rte. 278, N of Bluffton, local, along roadside through *Pinus palustris/Pinus elliottii/Serenoa repens* flatwoods on sandy spodosol soils, 4 Nov 2001, *McMillan 6055* (CLEMS). **Jasper Co.:** UTM 498600 E, 358900 N, *Pinus palustris/Pteridium/Quercus pumila/Aristida* flatwoods combining elements of both mesic and dry areas, 10 Aug 1995, *McMillan 1101b* (USCH).

Collections of *Liatris patens* have previously been identified as *L. graminifolia* or *L. gracilis*, both of which appear to be sympatric with the new species (Fig. 3). The apparent geographical coherence of *L. patens*, recorded here for ten counties in Georgia and two in South Carolina, is matched by its morphological consistency. *Liatris patens* is similar to *L. gracilis* in its cauline and peduncular vestiture and its pedunculate heads, but the new species has larger heads with more numerous florets and the peduncles are longer and arch upward to bear

erect or nearly erect heads. *Liatris patens* is similar to *L. graminifolia* in its relatively large heads and number of florets but different in its hirtellous-strigose stems and peduncles and long-pedunculate heads in a broadly racemoid inflorescence. Peduncles of *L. graminifolia* often are slightly elongate (0–3(–7) mm), sometimes more in plants with damaged stems, but the peduncles are almost always straight and divergent at ca. 45 degrees.

Distinctions among *Liatris patens* and close relatives are summarized in the following contrasts.

1. Stems and peduncles glabrous or nearly so; heads usually sessile or on short (0–3(–7) mm) peduncles, usually in a densely spiciform arrangement; involucres 7–12 mm high; florets 6–14 per head. ____ **Liatris graminifolia**
1. Stems and peduncles distinctly hirtellous-strigose with white hairs; heads on divergent, arcuate-ascending peduncles and loosely racemoid or nearly sessile but spreading; involucres (4–)5–7.5 mm high; florets 3–6(–7) or 7–12 per head.
   2. Peduncles (0–)2–10(–12) mm long, straight or slightly ascending; involucres cylindric-campanulate, (4–)4.5–6(–7) mm high, 3–4(–5) mm wide; florets 3–6(–7) per head. ____ **Liatris gracilis**
   2. Peduncles 10–25(–30) mm long, arching-ascending; involucres turbinate-campanulate, (5–)6–7.5 mm high, 5–7 mm wide; florets 7–12 per head. ____ **Liatris patens**

ACKNOWLEDGMENTS

We greatly appreciate the help of Bruce Hansen and Richard Wunderlin, who sent us photocopies of the collections of *Liatris savannensis* housed at USF, John Nelson, who sent photocopies of the USCH collections of *L. patens* from McIntosh Co., Ga., and Patrick McMillan, who sent a photocopy of the CLEMS collection from Beaufort Co., S.C. The collection citations from those institutions are based on the photocopies, which are filed in the BRIT herbarium. A loan of specimens was received from FLAS. The distinction of *Liatris patens* also has been recognized by Melanie DeVore, who began a study of the genus in connection with an FNA treatment but subsequently moved to other responsibilities. Bruce Hansen and the editor provided useful comments on the manuscript. We note that although neither species described here appears to be rare, at least during the periods when most of the collections were made, both are restricted in range and their conservation status needs to be evaluated by local and regional field study.

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BOOK NOTICES

Horticulture/Gardening

ROGER PHILLIPS and MARTYN RIX. 2002. **The Botanical Garden I: Trees and Shrubs.** (ISBN 0-55297-591-6, hbk.). Firefly Books Lt., 3680 Victoria Park Avenue, Toronto, Ontario M2H 3K1 CANADA. (Orders: www.fireflybooks.com, 416-499-8412, 416-499-1142 fax). $75.00 (US), $95.00 (CANADA), 492 pp. 2000+ color photos, 8 1/2 × 11".

ROGER PHILLIPS and MARTYN RIX. 2002. **The Botanical Garden II: Perennials and Annuals.** (ISBN 1-55297-592-4, hbk.). Firefly Books Lt., 3680 Victoria Park Avenue, Toronto, Ontario M2H 3K1 CANADA. (Orders: www.fireflybooks.com, 416-499-8412, 416-499-1142 fax). $75.00 (US), $95.00 (CANADA), 540 pp., 2000+ color photos, 8 1/2 × 11".

The Botanical Garden I and II is an impressive two volume set of modern day botany. It is billed as "a spectacular hybrid of gardening book and scientific text, with expert commentary..." Not only will one enjoy the beautiful photography, but there are interesting comments to read ranging from scientific and useful to fascinating and practical information. I'm glad to see that the toxic nature of some of the most common garden plants is discussed. The two volumes are fascinating and fun to browse or to search for specific plants and information. I've already found some interesting facts that will be useful in a future lecture. Enjoy!

Each taxonomic entry contains **Name** (genus, species and common names, date of discovery, and range), **Description** (detailed and concise in the scientific style), **Key Recognition Features**, **Evolution and Relationships**, **Ecology and Geography**, and **Comments**.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

DALLAS BAXTER (ed.). 2003. **Big Bend Gardener's Guide.** (No ISBN, pbk.). Native Plant Society of Texas, Big Ben Chapter, PO Box 1319, Alpine, TX 79831. (Orders: PO Box 1319, Alpine, TX 79831, bigbendwoman@brooksdata.net). $10.00, 32 pp., numerous line drawings, 1 map, 8 1/2 × 11".

Contents.—Welcome; Why Use Native Plants?; Planting Zone Map; Weather Data by Community; What Zone Are We In?; Tree Pruning Do's and Don'ts; Xeriscape: Landscaping for an Arid Climate; On NOT Following the Rules of Landscape Design; Plant List for the Trans-Pecos Region; Big Bend Places to See; The Deer Problem; Planting for Wildlife Chart; The Joys of Solarizing; Going Buggy: Integrated Pest Management; Catchwater Systems; Collecting/Harvesting Plants from the Wild; How to Plant a Tree; What is Making Me Sneeze? A Few Words on Plant Allergies; Cacti: Food for Thought; Some Thoughts on Soil; and Recommended Reading.

NEW COMBINATIONS IN *XANTHISMA* (ASTERACEAE: ASTEREAE)

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ABSTRACT

Xanthisma incisifolium (I.M. Johnston) Nesom, comb. nov. (*Machaeranthera pinnatifida* var. *incisifolia* = *Machaeranthera incisifolia*), and **Xanthisma glaberrimum** (Rydb.) Nesom & O'Kennon, comb. nov. (*Machaeranthera pinnatifida* var. *glaberrima*), are transferred at specific rank to the genus *Xanthisma*, newly expanded by Morgan and Hartman to include species segregated from *Machaeranthera* sensu stricto.

RESUMEN

Xanthisma incisifolium (I.M. Johnston) Nesom, comb. nov. (*Machaeranthera pinnatifida* var. *incisifolia* = *Machaeranthera incisifolia*), y **Xanthisma glaberrimum** (Rydb.) Nesom & O'Kennon, comb. nov. (*Machaeranthera pinnatifida* var. *glaberrima*), se transfieren con rango específico al género *Xanthisma*, ampliado de nuevo por Morgan y Hartman para incluir especies segregadas de *Machaeranthera* sensu stricto.

Molecular evidence (Morgan 2003) indicates *Machaeranthera* Nutt. sensu lato (Hartman 1990) is not monophyletic if the genera *Oonopsis* Nutt., *Pyrrocoma* Hook., and *Xanthisma* DC. (sensu Semple 1974) are excluded from it. In consequence, Morgan and Hartman (2003) have restricted *Machaeranthera* to two species and assigned the remaining species to three other genera, including *Xanthisma*. The latter is enlarged by Morgan and Hartman from a monospecific taxon to one including 17 species, and two additional taxa at specific rank are formally recognized here. Each of those added here is a member of the *Xanthisma spinulosum* (Pursh) Morgan & Hartman complex (= *Machaeranthera pinnatifida* sensu lato) and has been treated at varietal rank by Turner and Hartman (1976), Hartman (1990), and Morgan and Hartman (2003).

Xanthisma incisifolium (I.M. Johnston) Nesom, comb. nov. BASIONYM: *Haplopappus arenarius* Bentham var. *incisifolius* I.M. Johnston, Proc. Calif. Acad. Sci., ser. 4, 12:1190. 1924. *Machaeranthera pinnatifida* (Hook. f.) Shinners var. *incisifolia* (I.M. Johnston) Turner & Hartman, Wrightia 5:315. 1976. *Machaeranthera incisifolia* (I.M. Johnston) Nesom, Phytologia 69:112. 1990. *Xanthisma spinulosum* (Pursh) Morgan & Hartman var. *incisifolium* (I.M. Johnston) Morgan & Hartman, Sida 20:1409. 2003.

SIDA 20(4): 1585–1588. 2003

This Mexican taxon was earlier treated at specific rank (Nesom 1990), where it was noted that it is morphologically non-intergrading with other 'phases' of the *Machaeranthera pinnatifida* complex. It is restricted to San Lorenzo Island of Baja California Norte and the islands of San Esteban and Tiburón of Sonora.

Xanthisma glaberrimum (Rydb.) Nesom & O'Kennon, comb. nov. BASIONYM: *Sideranthus glaberrimus* Rydb., Bull. Torrey Bot. Club 27:621. 1900. *Machaeranthera pinnatifida* (Hook. f.) Shinners var. *glaberrima* (Rydb.) Turner & Hartman, Wrightia 5:311. 1976. *Xanthisma spinulosum* (Pursh) Morgan & Hartman var. *glaberrimum* (Rydb.) Morgan & Hartman, Sida 20:1408. 2003.

Xanthisma glaberrimum is an entity of the Great Plains, occurring from the Texas panhandle region northward into southeastern South Dakota and extreme west-central Minnesota. *Xanthisma spinulosum* (var. *spinulosum*) borders the distribution of *X. glaberrimum* on the south, west, and north. Turner and Hartman (1976, p. 311) observed that "Populations of [*X. glaberrimum*] seem fairly well-marked throughout most of Kansas and Nebraska and southern South Dakota, but to the western periphery of these regions they intergrade over a broad area into [*X. spinulosum*], especially in Oklahoma and the panhandle region of Texas." The somewhat contrasting observation is made here that reproductive isolation in this area of sympatry is at least as significant as intergradation, and in view of its morphological distinction and apparent isolation, a balance of evidence indicates that recognition at specific rank is appropriate for *Xanthisma glaberrimum*.

In recent floristic studies centered in Hutchinson, Moore, and Potter counties of the Texas panhandle (Nesom and O'Kennon in prep.), we have observed many sites where populations of *Xanthisma glaberrimum* and *X. spinulosum* grow in close proximity without intermediacy. A large array of herbarium collections also indicates that two morphological 'nodes' exist in this region (see contrasts in key below) and confirms the field experience. Evidence of introgression is seen, but even in such instances, *X. spinulosum* that shows characteristics of *X. glaberrimum* remains distinct from the latter at a population level, indicating the existence of reproductive isolation. For example, from Hutchinson County, *Nesom & O'Kennon 164* and *165* (BRIT) represent populations of *X. glaberrimum* (in typical form) and *X. spinulosum* (with strict, few-branched stems, similar to *X. glaberrimum* in habit but glandular and densely tomentose) that were growing at the same site—the two entities were distinct, with no intermediates observed in the field. Without the apparent introgression, the distinction is even more obvious. The direction of introgression appears to be primarily toward *X. spinulosum*—this species shows greater inter-populational variability, especially when it occurs in close proximity to *X. glaberrimum*, while the latter maintains a more stable morphology. In our field work, we have referred to these as the "gray thang" (= *X. spinulosum*) and "green thang" (= *X.*

glaberrimum) and rarely find it necessary to get closer than 5 meters to make an identification.

Collections at BRIT indicate that both taxa coexist in at least 10 of the 20 counties in the upper Texas panhandle region—this is considerably more of a mix than shown by the map in Turner et al. (2003). Herbarium material at BRIT indicates that a broad area of sympatry also occurs in adjacent Oklahoma. The area of sympatry was not indicated by the map in Turner & Hartman (1976, Fig. 42), and the Atlas of the Flora of the Great Plains (Great Plains Flora Association 1976) made no distinction between *Machaeranthera pinnatifida* var. *pinnatifida* and var. *glaberrima*.

Turner and Hartman (1976, p. 311) noted that "In eastern Wyoming, eastern Colorado, eastern New Mexico and the panhandle of Texas, the more typical, mostly pubescent, populations [of *Machaeranthera pinnatifida* var. *pinnatifida*] pass into the var. *glaberrima*, the two varieties often occurring near one another, but it is believed that this has resulted primarily from migration along road shoulders in relatively recent time, of var. *pinnatifida* into the regions of var. *glaberrima*, and perhaps vice versa." In contrast, however, Nesom and O'Kennon observe that the two taxa grow both with and without the other at many sites that appear to be relatively undisturbed and that are relatively distant from highway sides. The kind of morphological intergradation seemingly implied by the phrase "pass into" would be the impression from study of herbarium collections and reflect the recognition of gene flow (as also postulated above). Only the repeated field experience led us to interpret this intergradation with further perspective, and it is significant that Turner and Hartman's observation that the two occur "near one another" agrees with our own.

1. Stems usually unbranched until the upper third, the heads usually distinctly clustered; leaves strictly ascending, narrowly oblong in outline, 1-pinnatifid, midportion 1–2(–2.5) mm wide, lobes oblong-lanceolate to lanceolate or triangular, sometimes shallowly toothed, glabrous or less commonly lightly tomentose, eglandular or less commonly glandular; involucres cupulate. _____ **Xanthisma glaberrimum**
1. Stems branched from midstem or below to the upper third, the heads diffusely arranged; leaves loosely ascending to spreading, oblong to obovate in outline, especially the basal and lower cauline, 1–2-pinnatifid, midportion 0.5–1(–1.5) mm wide, lobes linear to lanceolate, usually shallowly toothed, usually glandular to varying degrees, slightly to densely tomentose, rarely without eglandular hairs; involucres shallowly hemispheric. _____ **Xanthisma spinulosum** var. **spinulosum**

Plants of *Xanthisma glaberrimum* with light tomentum were annotated in 1971 by R.C. Jackson as "var. *glaberrima* > subsp. *wootonii* (Greene) Jackson" (the combination by Jackson never published), but the type of *Eriocarpum wootonii* Greene was collected in the White Mountains of Lincoln Co., New Mexico, and is part of *X. spinulosum*. Its similarity in vestiture to some plants of *X. glaberrimum* is interpreted here as parallel. It seems likely that relatively un-

common plants of *X. glaberrimum* showing glandularity reflect gene flow from *X. spinulosum*, although their close relationship also suggests that parallelism is a possibility. Differences in pappus morphology noted by Turner and Hartman (1976) between *X. glaberrimum* and *X. spinulosum* have not been confirmed in the present study.

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A NEW SPECIES OF *SOLIDAGO* (ASTERACEAE: ASTEREAE) FROM NORTH CENTRAL ALABAMA

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ABSTRACT

A new goldenrod, *Solidago arenicola*, has been discovered from Blount County, Alabama. It is hereby described, figured, and contrasted with three other *Solidago* species, *S. plumosa* Small, *S. simplex* Kunth, and *S. erecta* Pursh, all of which have similar morphologies and are from the southeastern U.S.

RESUMEN

Una nueva vara de oro, *Solidago arenicola*, ha sido descubierta en el condado de Blount de Alabama. Aquí se describe, se ilustra y se contrasta con otras tres especies de *Solidago*, *S. plumosa* Small, *S. simplex* Kunth y *S. erecta* Pursh, que son del suroeste de los Estados Unidos y tienen morfologías similares.

The description below is based on several specimens, all from the same locality, which is the only locality from which *S. arenicola* has been collected to date. The collections were made along the Locust Fork River in Blount County, Alabama. The habitat at this location is shady, acidic woods in deep sandy alluvium on the river flood plain. These woods are commonly inundated by swiftly flowing water when the river overflows following heavy rains during the winter and early spring months. The drier summer and fall months aided by the porous sandy alluvium bring about a relatively dry substrate as the river recedes to a very small sluggish flow, well within the main channel.

Solidago arenicola B.R. Keener & Kral, sp. nov. (**Fig. 1**). TYPE: U.S.A. ALABAMA. Blount Co.: along E side of Locust Fork Branch of Black Warrior River, 0–1/4 mi S of Swann Bridge and ca. 1 mi W of Cleveland by Swann Bridge Road, 7 Sep 2002, *R. Kral 93190 & B.R. Keener* (HOLOTYPE: US; ISOTYPES: F, GA, MO, NCU, NY, TENN, UNA, USCH, VDB, WAT).

Planta inter *S. plumosa* Small et *S. simplex* Kunth et vars et *S. erecta* Pursh, species America borealis orientalis; differt a *S. plumosa* caulibus brevioribus, foliis basalibus brevioribus in ambitubus (ad apicem) latioribus, inflorescentiis angustioribus, acheniis longioribus; differt a *S. simplex* foliis pleurumque latioribus, involucris altioribus, acheniis longioribus et glabris; differt a *S. erecta* capitulis paucioribus, involucris altioribus; floribus disciformibus numerosioribus, corollis disciformibus longioribus.

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FIG. 1. *Solidago arenicola* B.R. Keener & Kral (from the type). **A.** Habit. **B.** Lower cauline leaf, abaxial view. **C.** Lower cauline leaf, adaxial view. **D.** Midcauline leaf, abaxial view. **E.** Uppermost cauline leaf, adaxial view. **F.** Head and upper portion of peduncle. **G.** Lower phyllary bract. **H.** Median phyllary. **I.** Inner phyllary. **J.** Ray floret. **K.** Disc floret post anthesis (left); expended anther.

Perennial (35–)40–80 cm tall from a short, horizontal to ascending rhizome, this and its branches apically caudex-like, to 5 mm thick, mostly imbedded in imbricated chaffy bases of older leaves. Stems erect, single or 2–3 approximate from rhizomal branches, terete, 2–4 mm thick at base, shallowly multicostate, glabrous save in inflorescence and its branches, there sparely to moderately hirtellous with short (0.2 mm or less), narrowly triangular, spreading or antrorsely curved multicellular hairs. Leaves alternate in high spiral, ascending to erect, margins coarsely scabro-ciliate, with ciliae antrorsely incurved and claw-like, the basal and lowermost leaves mostly spathulate to oblanceolate, 10–15 cm × 1.5–4 cm, blade below middle entire, gradually attenuate, to a slightly dilated clasping base, distal margins supramedially, coarsely ascending-serrate with long, shallowly convex or level-backed shallow teeth, apices acute to narrowly rounded, often to short, brownish, callused tips; distal cauline leaves gradually narrowing and shortening, ranging progressively to narrowly oblanceolate or narrowly elliptic, with apices more narrowly acute, margins entire, the uppermost 3.5–6 cm × 6–10 mm, there grading to widely ascending to spreading or even reflexed bracteal leaves; leaf surfaces glabrous, adaxially deep green with only the impressed midvein evident, abaxially pale with midvein raised and with sharply contrasting level network of deep green vein reticulum. Heads arranged into racemose or narrowly paniculate inflorescences, mostly with primary branches widely to narrowly ascending, the lowest usually longest with longer (often reflexed) bracts, from nodes 2–4 cm distant, and most floriferous, progressively shorter, becoming simple or with few-headed cymules, or primary axis simply a raceme of heads. Ultimate penduncles stiffly, widely ascending, angulate, slightly compressed, ca. 0.5 mm thick, stubby-bracteolate, scattered-hirtellous. Heads radiate, essentially turbinate, mature involucres 7–9 mm high, 0.7–1 cm wide at distal most point, phyllaries loosely spirally imbricate, 1–1.3 mm wide with pale, scarious-edged borders, and abaxially sunken midrib, this bordered by a narrow green band dilating apically to a narrow diamond, around a pale, elliptic depression, all with pilose-ciliate apices, lower ones 3–3.5 mm long, transitional from peduncular bracts, more green and shorter than upper, gradually grading to 5–6 mm, narrower, more acute from narrowly elliptic or oblong to linear-oblanceolate with broader, thinner pale borders. Pappus bristles of mature achenes of more or less equal lengths, 4–5 mm long, white, fine and finely barbellate, without evident dilated tips. Ray florets 6–10, carpellate, corolla tube ca. 3 mm long, ca. as long as pappus, blade mostly narrowly elliptic, 3–4 mm long, yellow, stigma branches to ca. 1 mm long, dull brown, mature achenes cylindric to somewhat elliptic 2–3.5 mm long. Disc florets 11–16, perfect, corolla at anthesis ca. 6 mm, dull yellow, tube ca. 3 mm, throat with 5 divergent, narrowly triangular lobes ca. 2 mm; staminal ring ca. 2.5 mm long; stylar cylinder at anthesis 4–4.5 mm, stigma branches barely divaricate, ca. 1.5 mm. Mature achenes cylindric to somewhat compressed, 3–4

mm long, typically 5-ribbed, glabrous, abruptly narrowed to a short "neck" surmounted by narrow, brownish pappus disc.

DISCUSSION

Following Nesom's (1993) taxonomic alignment of *Solidago* L., we find that *S. arenicola* is part of section *Solidago*; however, it is unclear as to which subsection the new species should be placed, it having affinities for species in both *Solidago* and *Albigula* (Raf.) Nesom. Within the subsection *Solidago*, a species complex, loosely referred to as the "Simplex Group," seems to share similar morphologies with *S. arenicola* (Semple per. com.). The Simplex group is currently thought to be composed of three species which include *S. plumosa* Small, a distinct rarity known only from along the Yadkin River in North Carolina, *S. simplex* Kunth, a more complex and widespread set of morphologies, transcontinental and essentially northern but with one subspecies from the rocky banks of the Potomac River in eastern Virginia [ssp. *randii* (Porter) Ringius var. *racemosa* (Greene) Ringius] and *S. spathulata* DC, which is of dune areas restricted to California and Oregon (Cronquist 1980; Cronquist 1994; Hitchcock & Cronquist 1973). The hypothesized relationship with the Simplex Group and *S. arenicola* is based on a suite of characters that *S. arenicola* shares with these three species, including caudiciform rhizomes, basally disposed, spathulate or oblanceolate, glabrous leaves, racemose or thrysoid-paniculate inflorescences that lack recurved-secund branching, heads turbinate/campanulate with 3–4 seriate phyllaries, ray florets 6–10 per head, and achenes up to 3 mm or more long. Of the subsection *Albigula*, which includes several species found in the southeastern U.S., only *S. erecta* Pursh could be considered close enough to *S. arenicola* morphologically to cause confusion about their identity. The wide-ranging *S. erecta* is known to occur from coastal Massachusetts and New Jersey, west to Indiana and south to northeastern Mississippi, central Alabama, and Georgia. In addition to the characters mentioned above associated with the Simplex Group, which apply here as well, *S. erecta* and *S. arenicola* also sometimes share almost indistinguishable foliage (stem leaves average larger in length and width in *S. erecta*), as well as very similar achene shape. (Cronquist 1980; Small 1933).

Differences that help distinguish the new species from similar species of *Solidago* that are known to occur in the southeastern U.S. are detailed in the key below:

1. Achene surface persistently short-hairy _____ **S. simplex**
1. Achene surface glabrous.
   2. Inflorescence axis and branches glabrous; achenes 2–3 mm long _____ **S. plumosa**
   2. Inflorescence axis and branches pubescent; achenes 3–4 mm long.
      3. Number of heads per stem usually more than 40, involucres 4–6.5 mm high, disc flowers usually 6–10 per head, disc corollas ca. 4 mm long _____ **S. erecta**

3. Number of heads per stem usually less than 30, involucres 7–9.5 mm high, disc flowers usually 12–16 per head, disc corol as ca. 6 mm long _____ **S. arenicola**

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BOOK NOTICES

Horticulture/Gardening

ALISTAIR SCOTT (Line drawings by HEATHER INSH). 2002. **A Pleasure in Scottish Trees.** (ISBN 1-84018-568-6, hbk.). Mainstream Publishing, Edinburgh and London. (Orders: Trafalgar Square, No. Pomfret, VT, U.S.A., 05053, 800-423-4525, www.trafalgarsquarebooks.com). $24.95, 202 pp., color photos, drawings, 6 × 9".

This book is described by the publisher as containing a combination of elements of forestry, identification, natural woodlands with a celebration of the wonderful wealth of trees flourishing in Scotland. The table of contents include: Native Woodlands, Native Trees, The Restoration of Native Woodland, Traditional Estates, Some Classic Sites of Plantation Forestry, Community Woodlands, Particular Conifers (29 taxa), Particular Broadleaves (31 taxa), followed by a Bibliography. There is NO index.

TIMBER PRESS

Horticulture/Gardening

KIRSTEN ALBRECHT LLAMAS. 2003. **Tropical Flowering Plants: A Guide to Identification and Cultivation.** (ISBN 0-88192-585-8, hbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $24.95, 180 pp., 75 color photos, 4 b/w photos, 2 tables, 11 drawings, 3 maps, 8 1/2 × 11".

KEY WORDS: **1)** Tropical plants; **2)** Identification; **3)** Pictorial Works. *From the dustjacket.*—"*Tropical Flowering Plants: A Guide to Identification and Cultivation* bridges a long-standing gap between obscure references in tropical botany and the gardener's need for an accurate, practical guide with clear photographs. Incorporating the latest advances in plant taxonomy from the definitive text of Dr. Walter Judd, the book is a rare work of scrupulous research—and magnificent photography—that will be as useful to the gardener as it is to the botanist." From the Acanthaceae (*Acanthus*) to the Zygophyllaceae (*Guaiacum*), this book is an encyclopedia of beautiful photographs and concise and specific descriptions of tropical plants. The book ends with three appendices: **1)** Invasive and Potentially Invasive Species; **2)** Rare, Endangered, and Threatened Species; **3)** Plants for Coastal Landscaping; and **4)** Xerophytic Plants. There is a Glossary, Bibliography, List of Web Sites and an Index of Scientific and Common Names.

SOLIDAGO FAUCIBUS (ASTERACEAE: ASTEREAE), A NEW MESIC FOREST GOLDENROD FROM THE APPALACHIAN MOUNTAINS

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ABSTRACT

Solidago faucibus, sp. nov., is described from two disjunct areas of the Appalachian Mountains: South Carolina and a contiguous area of Kentucky, Tennessee, Virginia, and West Virginia. The species is a decaploid ($2n = 90$) and has its affinities with the *Solidago arguta* group. It is distinctive in its extremely large leaves, especially on basal off-shoots, generally shorter inflorescence branches, large capitulae, uniformly pubescent achenes, and in forming large clonal (few-flowering) patches. Population variation, distribution, and habitat are discussed.

RESUMEN

Solidago faucibus, sp. nov., se describe de dos áreas disyuntas de los Montes Appalaches en Carolina del Sur y un área contigua de Kentucky, Tennessee, Virginia, y West Virginia. La especie es un decaploide ($2n = 90$) y tiene afinidades con el grupo de *Solidago arguta*. Se diferencia por sus hojas extremadamente grandes, especialmente en los renuevos basales, generalmente ramas de la inflorescencia más cortas, capítulos grandes, aquenios uniformemente pubescentes, y en formar grandes céspedes clonales (que producen pocas flores). Se discute la variación poblacional, distribución, y hábitat.

INTRODUCTION

The existence of an anomalous goldenrod became known to the first author while doing fieldwork in The Breaks of Russell Fork in Buchanan and Dickenson Counties, Virginia, in late summer of 1982. The plant was notable for its large size, especially its basal off-shoot (rosette) leaves. Initially there was uncertainty regarding its proper status, as there was some thought of its possibly being a hybrid (A. Cronquist, pers. comm.). Over the next 10 years, additional populations of the plant were found in eastern Kentucky, southern West Virginia, other locations in southwestern Virginia, and most recently in Tennessee. Notable in this regard, the populations showed a definite affinity for specific habitat parameters. That the plant recurs in the landscape over a fairly large geographic area and occupies a specific habitat type argues for its recognition as a species. It is herewith described as new.

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Solidago faucibus Wieboldt, sp. nov. (**Fig. 1**). TYPE: UNITED STATES. VIRGINIA. Lee Co.: dry hardwoods around top of N-facing limestone cliff on Powell River, just above Wilder Bend at river mile 135.6, SW of Jonesville, 24 Sep 1992, *T.F. Wieboldt 8429* (HOLOTYPE: VPI; ISOTYPES: NY, US, VDB, WAT).

Ex affinitate *Solidago arguta* Aiton, sed foliis basalibus laminis truncatis basaliter ad *S. harrisii* Steele similis, differt ramis floriferis brevibus, capitulis secundis inconspicuo, phyllaria nervis utroque costae latere, marginibus parallelis, apicibus rotundatis sparse ciliatis. Habitat in sylvis humidas apprime faucibus.

Herbaceous perennial from a branching caudex, generally producing 1–2 (several) lateral off-shoots terminated by a cluster of large rosette leaves. **Stems** erect, solitary, terete, 3–6 mm wide at base, 7.5–15 dm tall, glabrous below the inflorescence (and usually into the lower portion of the inflorescence). **Leaves** dull green above, pale below, the veinlets forming distinct areolae. Basal and lower cauline leaves with a pair of primary lateral veins arising 2–3 cm above the base of the blade and running most of its length. Basal offshoot leaves very large, petiolate, abruptly tapering to a winged petiole 10–20 cm long; blade ovate 12–22 cm long, 7–15 cm wide, broadly tapering to truncate or slightly cordate (rarely) base, apices acute, margin singly or doubly serrate with teeth 1–3(–6) mm. Lower stem leaves largest, slightly smaller than rosette leaves, petiolate, abruptly tapering to a winged petiole, ovate, progressively reduced upwards and becoming sessile, glabrous abaxially, scabrous-hispidulous adaxially at least along margins, serrate with teeth 1–3 mm long, 4–7 per cm. **Inflorescence** variable, mostly narrow and elongate, consisting of a slightly arching main axis 12–60 cm long with axillary and terminal racemiform branches 2.5–7(–13) cm, averaging about 4 cm, or, in sunny situations, wider and compounded, consisting of multiple inflorescence branches with short secondary racemes, leafy bracted below, branches and peduncles pubescent with short, stiff, upwardly curved, multicellular hairs. **Heads** large, few to many, inconspicuously secund on longer branches, appearing fasciculate on shorter branches, peduncles 2–5 mm (longer on South Carolina plants, 4–10(–13) mm). **Involucres** 4.5–7 mm. **Phyllaries** 10–18, in 4–6 series; median phyllaries averaging 3–4.5 mm long by 1–1.4 mm wide, lanceolate, broadly acute to obtuse, glabrous except for fimbriate-ciliate margins towards tip, ascending; midvein heavy and dark, slightly resinous and raised in distal portion, a pair of lateral veins commonly present, sometimes evident as interrupted lines, or occasionally only as a short resinous line in the distal half. **Ray florets** 4–6; strap 2.2–3.5 mm, 0.8–1.7 mm wide. **Disc florets** 5–7(–11), corollas 4.0–5.6 mm, lobes 1.6–2.5 mm, stigmatic lobes 1–1.3 mm, anthers 2–2.9 mm. **Achenes** 2.5–3.2 mm long, short pubescent at least on upper half, somewhat variable within populations; pappus bristles 3–4.7 mm. Chromosome number $2n = 90$.

Etymology.—The species epithet *faucibus* is taken from the phrase "*in faucibus crescens*" meaning "growing in the gorges" (Stearn 1983). The common name "Gorge Goldenrod" is suggested in reference to its preferred habitat.



FIG. 1. *Solidago faucibus* Wieboldt based on collections from the type station, Lee County, Virginia. Rootstock with basal leaves and offshoot, inflorescence, flower head (side view), median phyllary, achene with pappus.

Additional specimens examined: **KENTUCKY: Breathitt Co.:** Robinson Forest, 9 Oct 1982, *W. Meijer s.n.* (KY). **Clay Co.:** base of E-facing slope with much *Laportea canadensis*, Redbird River, 0.1 mi N of Kates Creek, Daniel Boone National Forest, Creekville Quad., 37°2'12"N, 83°32'25"W, 30 Jul 1992, *Allen C. Risk 6330* (MDKY). **Leslie Co.:** Red Bird River, mesic hardwoods at toe of SW-facing slope at mouth of Bowen Creek, 1.5 km SE of Creekville, 24 Sep 1992, *T.F. Wieboldt 8422, J. Campbell, and D. Taylor* (VPI); abandoned picnic area, hemlock woods, US-421 S of Stinnel, just S of where highway crosses the river, 14 Sep 1991, *J.C. Semple 9619 and B.A. Suripto* (WAT); moist soil, shaded lower slope in south flowing ravine, 1.5 mi SE of F.S. Rd. 1530 from junction KY 66 and F.S. Rd. 1530 in Bowen Creek, 17 Sep 1993, *James D. Kiser 371* (MDKY); low steep banks near gullies, along Kentucky River opposite Frontier Nursing Services, 9 May 1990, *J. Campbell s.n.* (KY); same locality, Jul 1991 & 6 Sep 1991, *J. Campbell s.n.* (KY). **Letcher Co.:** wooded ravine and hillsides near big Everidge entrance, gravelly road bank, full sun, Lilly Cornett Woods State Preserve, 4 Oct 1974, *J. Stuart Lassetter 2361* (EKY). **Owsley Co.:** slopes along Brushy Creek, Sturgeon, 22 May 1990, *J. Campbell s.n.* (KY). **SOUTH CAROLINA: Pickens Co.:** SR-39-98, E of US-178, 17 Oct 1981, *Semple and Chmielewski 6170* (WAT); in rich deciduous woodlands with circumneutral or ultramafic soils on slopes above Eastatoe Creek, 0.8 km E of bridge on St. Rt. 143 (Roy F. Jones Hwy), 8 Sep 2001, *P.D. McMillan 5866* (CLEM); dry, medium-aged successional woodland S of Roy F. Jones Hwy, 1.1 km W of jct. Hwy 11, 2 Oct 2002, *T.F. Wieboldt 11083* (VPI). **TENNESSEE: Campbell Co.:** mesic hardwoods dominated by sugar maple, toe of N-facing slope above Hwy 25W where Clear Fork cuts through Pine Mountain, 4 mi W of Jellico, 18 Jun 2003, *T.F. Wieboldt 11206* (VPI); **Hancock Co.:** 02-302, Short Mt. Rd. 0.1-0.2 mi above church, 7 Oct 2002, *H.R. DeSelm s.n.* (TENN). **VIRGINIA: Buchanan Co.:** Breaks Interstate Park, rich hardwoods along Grassy Creek, Oct 1982, *F. Levy s.n.* (VPI); base of mesic hardwood slope, Knox Creek 4.6 km NW of Hurley, 14 Sep 1991, *T.F. Wieboldt 7913 and D.W. Ogle* (VPI). **Dickenson Co.:** Breaks Interstate Park, mesic, rich hardwoods along Russell Fork just above Garden Hole parking, 25 Aug 1982, *T.F. Wieboldt 4483, A.B. Davenport, F. Levy, M. Medley, and M. Palmer* (VPI); same locality, 22 Sep 1992, *T.F. Wieboldt 8417* (VPI). **Giles Co.:** limestone bottomland, deep woods, Rt. 649 N of Glen Lyn, 16 Aug 1973, *L.J. Uttal 10217* (VPI). **Lee Co.:** ledges, summit, and adj. woods around high, N-facing limestone cliff, Powell River just above Wilder Bend, 6.8 km SW of Jonesville, 24 Sep 1985, *T.F. Wieboldt 5893* (VPI), (type station). **Scott Co.:** seepage area near base of high, E-facing cliff along Guest River 0.15 km above confluence with Clinch River, 8.5 km SE of Coeburn, 9 Aug 1985, *T.F. Wieboldt 5825 and A.B. Wieboldt* (VPI). **Tazewell Co.:** oak-dominated mixed hardwoods on narrow, rocky (limestone) ridgeline between Clinch River and Indian Creek at Cedar Bluff, 6 Aug 1997, *T.F. Wieboldt 9769* (VPI). **Wise Co.:** Guest River gorge, 14 Sep 1984, *D.W. Ogle s.n.* (VPI). **WEST VIRGINIA: McDowell Co.:** very dry hillside, Route 52, Keystone, 9 Sep 1962, *F. Rusinke s.n.* (WVU). **Mercer Co.:** mesic stream bottom woods from toe of slope to rocky riverbank, 0.75 mi below Eads Mill along Bluestone River, 2 Oct 1984, *T.F. Wieboldt 5352 and C. Douglas* (VPI); near base of NE-facing outcrops, mesic hardwoods just above road along New River 0.25 mi W of Virginia line, 30 Aug 1985, *T.F. Wieboldt 5945* (VPI). Duplicate specimens are to be distributed.

The range of *Solidago faucibus* coincides closely with that of the Appalachian coalfield region, which may account, in part, for its having gone unrecognized for so long. This rugged terrain of narrow winding valleys cut into the Appalachian and Cumberland Plateaus is, with few exceptions, poorly botanized due to difficulties of travel and remoteness from population centers.

Solidago faucibus appears to have affinities to *Solidago arguta* Aiton. The *Solidago arguta* group has been variously defined by different authors (see Morton 1973, and references therein). Shared characters with the core members of the group include having the basal leaves largest and progressively reduced upwards, secund flowering branches, glabrous round stems (below inflorescence),

hirtellous pedicels and inflorescence branches, and glabrous abaxial leaf surfaces (Small 1933). The confusion and difficulties in the group are amply described by Morton (1973). As a direct result of these concerns, considerable hesitancy has been exercised in naming this species. The species bears a close resemblance to *Solidago arguta* var. *harrisii* (Steele) Cronq. In fact, the earliest known collection of the species is that of E.L. Braun who reported it as *Solidago harrisii* (Braun 1943; Campbell 1993). *Solidago harrisii* was described by Edward S. Steele (1911) from the shale barrens of the central Appalachians. It was subsequently considered part of the endemic flora of these unique habitats (Keener 1983, but see also Braunsweig et al. 1999). Whether treated as a species or a variety of *S. arguta*, the taxon has subsequently been found to occur with high fidelity in association with limestone cliffs over a considerably broader region. While Braun's plant proves to be *S. faucibus*, true *S. arguta* var. *harrisii* has since been found in remote areas of eastern Kentucky (J. Campbell, pers. comm.).

Cytology.—Chromosome counts of $2n = 90$ have been determined from three locations. First, Semple et al. (1993) reported a chromosome count of $2n = 90$ for *S.* aff. *flexicaulis* L. from Leslie County, KY. *Solidago flexicaulis* was otherwise known to be tetraploid or hexaploid (Semple et al. 1984). Leslie County, KY, is one of the areas where multiple populations of *S. faucibus* are known; the voucher (*Semple & Suripto 9619* WAT) is *S. faucibus*. Second, Semple et al. (1984) reported $2n =$ ca. 96 for *S.* cf. *glomerata* Michaux from Pickens Co., South Carolina. The voucher (*Semple & Chmielewski 6170* WAT) was reexamined and also found to be a plant of *S. faucibus*. Review of notes indicate the count was redone later and confirmed to be $2n = 90$, but not yet corrected in the literature. Third, when plants of an *arguta* type were found in South Carolina by Patrick McMillan, photos were sent to the first author to see if they might be the as yet unnamed taxon. After seeing the plants in the field in the fall of 2002, the first author confirmed that they were the same despite a few minor differences. Live plants were sent to the second author who determined that they also were $2n = 90$. In *Solidago*, chromosome numbers of $2n = 90$ are otherwise known only for *S. lancifolia* Torr. & A. Gray, from which *S. faucibus* is readily distinguished (*S.* subsect. *Glomeruliflorae*; Rachel Cook and J.C. Semple, pers. comm.).

DISCUSSION

The most striking feature of *Solidago faucibus* is its large rosette leaves which often form large patches (clones?) with few flowering stems. In addition, several diagnostic characters serve to distinguish *S. faucibus* from members of the *S. arguta* group. Inflorescence shape is of critical importance in goldenrod taxonomy. The disposition of heads along the upper side of inflorescence branches is made conspicuous in *S. arguta* by the widely spreading branches which are

often naked or few-flowered proximally. In *S. faucibus*, the branches of typical woodland plants are short, floriferous to the leaf axil, and inconspicuously secund, often suggesting an elongated axillary thyrse. The secund nature of the inflorescence may be obscured even more in pressed specimens. Often, only the longest (basal-most) branches display the secund condition. Given an abundance of sunlight in disturbed areas and along woods roads, primary branches may be more elongate with secondary branching being similarly thyrsoid to short racemose. It is these open-grown plants with their more open architecture that somewhat disguises their identity since their primary branches may be clearly secund. Nevertheless, the basal off-shoots and involucral bracts readily identify them.

The involucral bracts of *Solidago faucibus* provide additional key characters which are especially helpful in distinguishing it from *S. arguta* var. *harrisii*. Median involucral bracts clearly show the presence of a lateral vein on either side of the midvein. It is sometimes discontinuous and may show more clearly in the distal half. The median phyllaries are parallel-sided with a rounded, sparsely ciliate tip. These two features clearly differentiate it from *S. arguta* var. *harrisii*, which has only a single midvein and phyllaries that taper most of their length with barely discernible marginal hairs at the tip. Although leaf shape of *S. arguta* var. *harrisii* is nearly identical, that variety's widely spreading inflorescence normally identifies it without having to resort to involucral characters.

The multinerved condition of the phyllaries does not fit Nesom's characterization of *Solidago* subsect. and ser. *Argutae* (Mackenzie in Small) Nesom (Nesom 1993). However, multinerved phyllaries occur in other species in other subsections as well: *S. roanensis* Porter in subsect. *Albigulae* (Raf.) Nesom; *S. glomerata* and *S. lancifolia* in subsect. *Glomeruliflorae* (Torr. & A. Gray) Nesom; the well known oligoneurate species of sect. *Corymbosae* Torr. & A. Gray (the genus *Oligoneuron* in Nesom 1993, 2000).

Due to its abruptly narrowed leaf bases and more constricted inflorescence compared with typical *S. arguta*, the new species can be confused with *S. flexicaulis*. The large size is an important consideration because herbarium specimens may lack the lower stem leaves which are crucial in aligning it with *S. arguta* rather than *Solidago* subsect. *Glomeruliflorae*. *Solidago flexicaulis*, as well as other members of its subsection, has its largest leaves near mid-stem or even closer to the inflorescence. Lower stem leaves are generally absent at flowering time.

Typical *Solidago arguta* is found commonly throughout the region in drier sites. On rare occasions, it is found within a few feet of *Solidago faucibus*, in which case the two are readily distinguishable with no intermediates being found. Any intermediates would be cytologically very distinct being either $2n = 54 (= 9 + 45)$ or $2n = 63 (= 18 + 45)$.

Population variation.—Apart from the unifying characters discussed above, *Solidago faucibus* displays considerable population variation in several morphological characters. These include leaf vestiture, leaf toothing, inflorescence branch length, involucre length, peduncle length, and disposition of capitulae (secund or not). A geographical trend is noted in South Carolina plants although not all plants display it to the same degree.

Leaves are sparsely scabrous-hirsutulous above. The zone of hairs is typically marginal but varies in width up to about 1 cm wide, especially toward the leaf tip. Scabrous hairs sometime occur more widely on veins. South Carolina plants are scabrous-hirsutulous over most or all of their upper surfaces. Marginal teeth of basal and rosette leaves vary from single, low (1 mm) serrations to doubly serrate with jagged teeth (3 mm). Individual populations are quite uniform, however. Inflorescence branch length is quite variable and appears to be partly environmentally controlled. The longest branches occur on South Carolina plants, which display a general tendency toward elongation of parts. Peduncles are longer (4-10 mm vs. 2–4 mm), involucres average longer, although the ranges are only slightly skewed toward the long end of the range, and stigmas and anthers are longer. Plants from The Breaks (Buchanan and Dickenson Counties, Va.) with uniformly tight inflorescence branches, when transplanted to full sun, produced elongate primary branches with short, secund secondary branching. These populations also have the least coarsely toothed leaves and leaf blades with noticeably longer length:width ratios. As noted above, heads on the short inflorescence branches are inconspicuously secund in most populations. This condition is barely noticeable in the Bluestone River population (Mercer Co., W. Va.), which otherwise fits well into the species concept. South Carolina plants are similarly thyrse-like with the slight secund condition being further obscured by the longer peduncles. South Carolina populations seem to flower very infrequently, however, so relatively few flowering stems have been observed. The rosette leaves of South Carolina plants are more truncate to slightly cordate at the basal angle, and basal rosettes are produced on longer off-shoots than the more northern populations.

The high polyploid condition may be a factor in population variation. Multiple copies of the genome could provide an inherent variability with different phenotypic expressions being favored in different populations. It is not known whether the 10*x* chromosome number is the result of sequential autopolyploid events with divergence from a single species of *Argutae*, the result of allopolyploid events involving several species of *Argutae*, or the result of a combination of autopolyploidy and allopolyploidy. If allopolyploidy were involved, then *S. faucibus* would likely include greater genetic variation.

Habitat.—*Solidago faucibus* occupies the most mesic habitats of any species in the *S. arguta* group. It is especially tolerant of deep shade, not uncom-

monly growing under *Tsuga canadensis* (L.) Carr., eastern hemlock. Nevertheless, it is also tolerant of a wide range of moisture conditions and bedrock types. The species most often occurs along rivers and major streams where they are entrenched in the surrounding landscape. In the Cumberland and Appalachian Plateaus and the Ridge and Valley Province, gorge-like conditions frequently occur where streams cut through more resistant rocks. It is near the base of these steep, often rocky, slopes that *S. faucibus* is most often found, being conspicuously absent from the gentler terrain of intervening areas. In this rugged landscape, forests are frequently intact and typically support a very mesic, mixed hardwood association. In limestone districts, the species may occupy considerably more open cliff sites.

KEY TO SPECIES OF *SOLIDAGO* SER. *ARGUTAE*

1. Leaves minutely scabrous, puberulent or short villous, blades attenuate at base.
   2. Leaves scabrous on upper surface, the hairs very short and with swollen bases; bogs, swamps, and seepage wetlands _____ **S. patula**
   2. Leaves soft villose or puberulent.
      3. Rays usually 7–12; leaves moderately to densely short villose; spring blooming; coastal plain of N.C., S.C. _____ **S. verna**
      3. Rays none, rarely 1-2; leaves densely and finely puberulent; fall blooming; open woods, coastal plain and piedmont, S.C. to Ala. (possibly Miss.) _____ **S. brachyphylla**
1. Leaves glabrous or nearly so, or if scabrous above, the blades abruptly contracted or truncate at base.
   4. Phyllaries striate, several veins enlarged, involucres 4.5–7 mm; Va., W.Va., Ky., Tenn., S.C. _____ **S. faucibus**
   4. Phyllaries not striate, only main vein enlarged (very rarely more striate in *S. arguta*).
      5. Plants without slender stoloniferous rhizomes _____ **S. arguta** (including *S. harrisii*)
      5. Plants with slender stoloniferous rhizomes in addition to main more deeply situated rhizome or caudex.
         6. Lower leaves elliptic to obovate (ovate), acute, with obtuse to attenuate base; upper stem leaves quickly reduced and ascending to appressed _____ **S. ludoviciana**
         6. Lower leaves mostly ovate, acute to acuminate, with truncate to obtuse base; upper stem leaves gradually reduced, rarely appressed _____ **S. tarda**

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and helpful suggestions concerning the draft manuscript. Duncan Porter and Andrew Becker helped resolve questions about the proper form of the species epithet.

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BOOK NOTICES

TIMBER PRESS

Horticulture/Gardening

JOHN C. MANNING, PETER GOLDBLATT, and DEE SNIJMAN. 2002. **The Color Encyclopedia of Cape Bulbs.** (ISBN 0-88192-547-0, hbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $59.95, 486 pp., 611 color photos, 2 color maps, 2 tables, 8 1/2 × 11".

The title just about says it all. The book is filled with excellent color photographs, it is encyclopedic (nearly 1200 species), and it is all about bulbous and beautiful plants that grow in the Cape Floral Region at the southern tip of Africa. Included at the end is a Conversion Table, Specialist Suppliers, Glossary, References, Index of Synonyms, and an Index of Common Names. Well done thou good and faithful servants! See notice (Sida 19(2), 2000) on a previous book by two of the authors (Goldblatt and Manning) *Wildflowers of the Fairest Cape*.

DAVID MORE and JOHN WHITE. 2002. **The Illustrated Encyclopedia of Trees.** (ISBN 0-88192-520-9, hbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $79.95, 800 pp., 4500 color plates (watercolors), 7 1/4 × 10 3/8".

Even though the trees selected and illustrated are commonly cultivated in England and continental Europe, many are found here in American gardens and many are native to North America. This is a beautiful work that took 12 years compile. Deciduous trees are illustrated with both a summer painting in full leaf and a winter silhouette. Both deciduous and evergreen trees are illustrated as well with a close-up artwork detailing leaves or needles, bark, blossoms, fruit, nuts, or cones. More than 1800 species and cultivars are detailed in this beautifully done work.

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Contents.—Preface, Acknowledgments, Introduction, Postharvest Care, Drying and Preserving, Cut Flowers: *Achillea* to *Zinnia*, References, Appendix I: Stage of Harvest; Appendix II: Additional Plants Suitable for Cut Flower Production; Appendix III: Useful Conversions; U.S. Department of Agriculture Hardiness Zone Map, Index of Botanical Names, and Index of Common Names.

NEW NAMES AND COMBINATIONS IN GOLDENRODS, *SOLIDAGO* (ASTERACEAE: ASTEREAE)

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ABSTRACT

The following new names and combinations in *Solidago* are proposed: ***Solidago*** subsect. ***Multiradiatae***, ***Solidago*** subsect. ***Humiles***, ***Solidago*** ser. ***Auriculatae***, ***Solidago*** ser. ***Odorae***, ***Solidago*** ser. ***Drummondiani***, ***S. altissima*** subsp. ***gilvocanescens***, ***S. kralii***, ***S. lepida*** subsp. ***fallax***, ***S. lepida*** var. ***salebrosa***, ***S. odora*** subsp. ***chapmanii***, ***S. patula*** subsp. ***strictula***, ***S. puberula*** subsp. ***pulverulenta***, ***S. rugosa*** var. ***cronquistiana***, ***S. sempervirens*** subsp. ***azorica***, ***S. sempervirens*** subsp. ***mexicana***, ***S. speciosa*** subsp. ***pallida***, ***S. stricta*** subsp. ***gracillima***, ***S. velutina*** subsp. ***californica***, and ***S. velutina*** subsp. ***sparsiflora***.

RESUMEN

Se proponen los siguientes nombres y combinaciones nuevos en *Solidago*: ***Solidago*** subsect. ***Multiradiatae***, ***Solidago*** subsect. ***Humiles***, ***Solidago*** ser. ***Auriculatae***, ***Solidago*** ser. ***Odorae***, ***Solidago*** ser. ***Drummondiani***, ***S. altissima*** subsp. ***gilvocanescens***, ***S. kralii***, ***S. lepida*** subsp. ***fallax***, ***S. lepida*** var. ***salebrosa***, ***S. odora*** subsp. ***chapmanii***, ***S. patula*** subsp. ***strictula***, ***S. puberula*** subsp. ***pulverulenta***, ***S. rugosa*** var. ***cronquistiana***, ***S. sempervirens*** subsp. ***azorica***, ***S. sempervirens*** subsp. ***mexicana***, ***S. speciosa*** subsp. ***pallida***, ***S. stricta*** subsp. ***gracillima***, ***S. velutina*** subsp. ***californica***, y ***S. velutina*** subsp. ***sparsiflora***.

The following new names and combinations were determined to be needed during work to prepare the treatment of *Solidago* for *Flora North America* (Semple & Cook, submitted). Ten of the new combinations treat taxa as subspecies that usually have been recognized as varieties. The definitions of the ranks follow Semple (1974). In each case, the subspecies is morphologically distinct and has a distribution that is nearly allopatric from the other subspecies within the respective species. Intermediates between the subspecies occur in the areas of sympatry. Ranges of varieties overlap considerably, with pure and intermediate populations occurring intermixed within the range of the variety. Hamilton and Reichard (1992) noted inconsistencies in application of the ranks to taxon, and some of the combinations proposed here correct such inconsistencies within *Solidago* in North America. Subsection and series names are proposed to fit my opinions on how species should be grouped within the genus; a full infrageneric nomenclature is included in Semple and Cook (submitted).

Solidago subsect. **Multiradiatae** (Juz.) Semple, comb. nov. BASIONYM: *Solidago* ser. *Multiradiatae* Juz., Fl. U.R.S.S. 25: 47. 1959. TYPE: *Solidago multiradiata* L.

Solidago subsect. **Humiles** (Rydb.) Semple, comb. et stat. nov. BASIONYM: *Solidago* (sp.-group) *Humiles* Rydb., Fl. Rocky Mts. 868. 1917. TYPE: *Solidago humilis* A. Gray (1884), non Pursh (1814). [= *S. simplex* Kunth]

Solidago ser. **Auriculatae** Semple, ser. nov. TYPE: *Solidago auriculata* Shuttlew. ex S.F. Blake

Solidagini subsect. *Argutae* (Mackenzie) Nesom accedens sed foliis auriculatissimis differt.

The leaves are distinctly auriculate clasping. The basal leaves are largest and petiolate like other *Argutae*.

Solidago ser. **Odorae** (Mackenzie in Small) Semple, comb. et stat. nov. BASIONYM: *Solidago* (sp.-group) *Odorae* Mackenzie in Small, Man. SE. Fl. 1345, 1346. 1933. *Solidago* subsect. *Odorae* (Mackenzie in Small) Nesom, Phytologia 75:10. 1993. TYPE: *Solidago odora* Aiton.

Solidago ser. **Drummondiani** Semple, ser. nov. TYPE: *Solidago drummondii* Torr. & A. Gray.

Solidagini ser. *Venosae* G. Don accedens sed foliis caulis ovatis triplinervis differt.

Lower mid stem leaves ovate, serrate and with two, large, lower lateral veins (triple-nerved) as well as additional less enlarged upper lateral veins

Solidago altissima L. subsp. **gilvocanescens** (Rydb.) J.C. Semple, comb. et stat. nov. BASIONYM: *Solidago canadensis* L. var. *gilvocanescens* Rydb., Contr. U.S. Natl. Herb. 3:162. 1895. *Solidago gilvocanescens* (Rydb.) Smyth, Trans. Kansas Acad. Sci. 16:161. 1899. *Doria gilvocanescens* (Rydb.) Lunell, Amer. Midl. Naturalist 5:43. 1917. *Solidago canadensis* L. ssp. *gilvocanescens* (Rydb.) Löve & Löve, Taxon 31:358. 1982. *Solidago altissima* L. var. *gilvocanescens* (Rydb.) Semple, Phytologia 58:430. 1985. TYPE: U.S.A. NEBRASKA. Hooker Co.: Cody's Lakes at the head of the Dismal R, sandy soil, 10 Aug 1893, *Rydberg 1662* (HOLOTYPE: US, photo!; ISOTYPES: GH!, NY2, photos!).

Subspecies *gilvocanescens* includes diploids and tetraploids of *S. altissima* found across the Great Plains from southern Canada to Texas. Subspecies *altissima* includes hexaploids throughout its range in eastern North America from the edge of the Great Plains eastward from Nova Scotia to northern Ontario and eastern Manitoba south to northern Florida and eastern Texas; a few tetraploids are known from Arkansas and Tennessee. The subspecies differ in head and floret size and are difficult to distinguish where the two ranges overlap.

Solidago kralii Semple, sp. nov. (**Figs. 1–11**). TYPE: U.S.A. GEORGIA. Pulaski Co.: ca. 1–1.5 mi S of jct. US-341 and GA-230 at Hartford, longleaf pine scrub hills, 10 Aug 1975, *R. Kral 56345* (HOLOTYPE: VDB!; ISOTYPE: MO!).

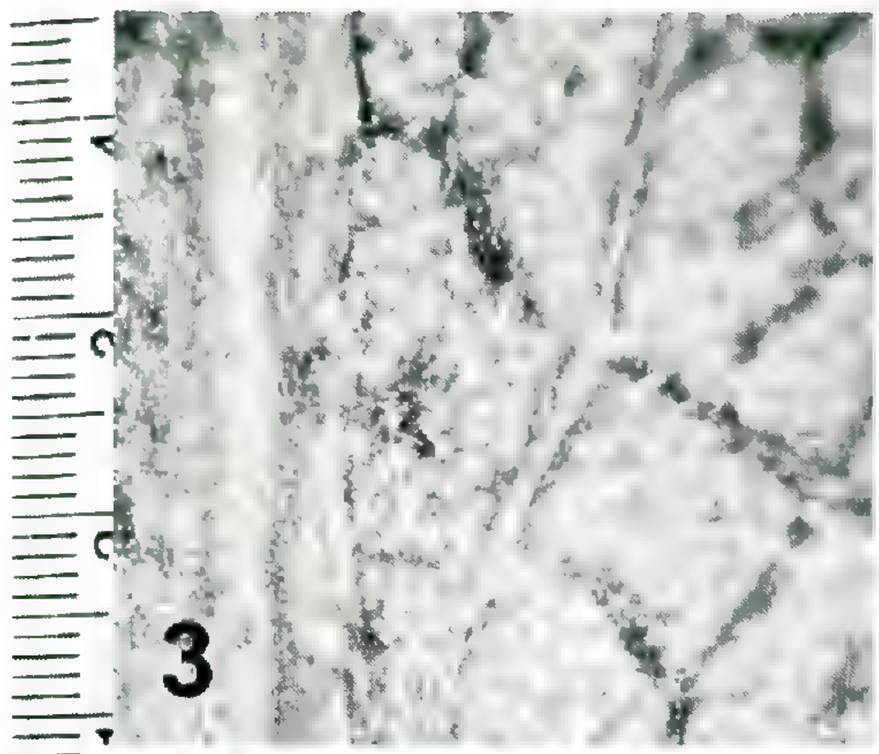
Solidagini plumosa Small accedens sed capitulescentiis viscidis resinosisimis differt.

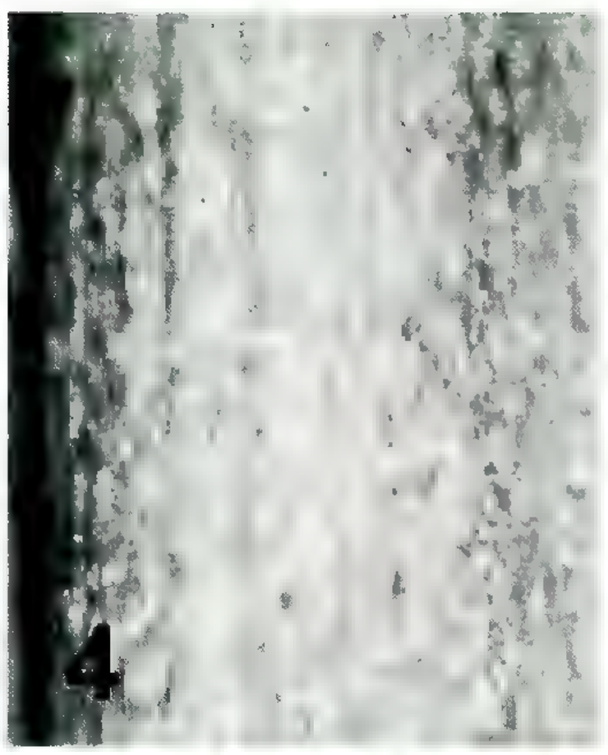
Herbaceous perennials from creeping rhizomes. Stems 6.5–12 dm tall, glabrous to sparsely strigulose in capitulescence, often copiously viscid resinous in capitulescence. Basal leaves petiolate, blade gradually tapering to winged petiole, oblanceolate, (2.5–)10–20 cm long, (4–)15–28 mm wide, main vein prominent,



FIG. 1. Holotype of *Solidago kralii, R. Kral 56345* (VDB).















FIGS. 2–8. Details of the morphology of *Solidago kralii*. **2.** Mid stem leaf, scale bar in cm. **3.** Mid stem leaf surface detail by mid vein. **4.** Stem. **5.** Portion of capitulescence. **6.** Capitulum. **7.** Involucre. **8.** Mature cypsela, glabrous body, scale bar = 1 mm.



FIGS. 9–11. Ecology of *Solidago kralii*. **9.** Road margin habitat through sand hill; Ben Hill Co., Georgia (*Semple & Semple 11216*). **10.** Habit of 1 m tall robust individual; Richmond Co., Georgia *(Semple & Semple 11217*). **11.** Large bee visitor on flowering head; Pulaski Co., Georgia *(Semple & Semple 11208*).

membranous, glabrous, viscid, margins shallowly serrate apically, teeth less than 1 mm long, finely ciliate; rosettes present at flowering, forming at the ends of elongated rhizomes, first leaves produced the smallest. Lower to mid stem leaves similar to basal to sessile and linear elliptic, quickly reduced, mid stem leaves 4–8 cm long, 6–9 mm wide, reduced upward, viscid, entire. Upper stem leaves sessile, linear elliptic to linear, 10–35 mm long, 1–3 mm wide, reduced into capitulescence, glabrous, viscid. Capitulescence narrowly thyrsiform

paniculiform, 9–30(–40) cm long, 4–7(–12) cm wide, longer branches ascending, 2–4(–15) cm long; heads 1–9(–15) per branch. Peduncles sparsely strigulose, somewhat to copiously resinous, naked below to bracteolate near heads, bracteoles usually 1–3. Involucres campanulate, 5–7 mm high. Phyllaries in 3–4 strongly graduated series, the outer ovate 1.5–2 mm long, middle ones 3–4 mm long, narrowly ovate, to 1.5 mm wide, inner linear lanceolate, apex obtuse, rounded to slightly cuspidate, ciliate, surfaces often copiously resinous, very sparsely finely strigose and obscured by exudate. Ray florets 3–5(–11), strap 2.5–3.5 mm long, 1–1.5 mm wide. Disc florets 10–16(–20), corolla 5–6 mm long, lobes 1–1.5(–1.8) mm long. Cypsellae fusiform to narrowly obconic, 3–5 mm long, 5–8 golden brown thin ribs darker than intercostal portions, glabrous; pappus bristles 4–5 mm long, sometimes strongly clavate. $2n = 18$.

Flowering August–September. Turkey oak and pine scrub sandhills; Ga., S.C.

Kral's Goldenrod is closely related to *S. simplex* Kunth, *S. plumosa* Small and *S. arenicola* Kral & Keener, the latter two and *S. kralii* possibly being divergent and isolated relicts of a common ancestor more widely distributed across the southeastern United States during late glacial times. *Solidago kralii* is often much more copiously viscid resinous then these other three species. The involucres of *S. arenicola* are much taller than those of *S. kralii* and *S. plumosa*. Recently made field collections of *S. kralii* tended to stick somewhat to the newsprint in which specimens were dried. *Solidago kralii* is nearly always found in full sun on sandhills (Fig. 9); the sites can be highly disturbed. Population sizes varied from one to several dozen or more individuals, the exact number not being determined during recent field observations. Individuals were observed in the field with more than three dozen robust shoots up to 1 m tall (Fig. 10). In general, plants of *S. arenicola* observed in the field in September 2003 were much shorter, had fewer shoots, and were only found in partially shaded sandy soils of river banks in northern Alabama. *Solidago plumosa* can be as tall as *S. kralii*, but it is known is only from the type location in Stanly Co., North Carolina on a very limited section of the rocky margins of the Yadkin River, a habitat observed in September 2003 that was, prior to dam construction, probably similar to the habitat of tetraploid *S. simplex* var. *racemosa* (E.L. Greene) Ringius along the Potomac River near the Great Falls of the Potomac in Maryland observed in 1984 (*Semple & Ringius 7663* WAT; Ringius and Semple 1987).

Chromosome counts for *S. kralii* determined from two locations were both were diploid: $2n = 18$, **U.S.A. Georgia. Pulaski Co.:** S of Hartford, GA-230 1 km SE of US-341/GA-27, 23 October 2001, *R. Cook et al. 701* (WAT; shoots well past blooming); $2n = 9_{II}$, **U.S.A. Georgia. Richmond Co.:** US-1, NE of Blythe, S of Ellis Pond, steep roadside embankment, sand hill, 7 Sep 2003, *J. Semple & B. Semple 11217* (WAT).

The species is named in honor of Dr. Robert Kral (VDB) who collected the specimens that first brought the species to my attention. He is well known for

his work on the flora of the southeastern United States over many years and for his numerous collections deposited in VDB and duplicates in many other herbaria in eastern North America.

Additional collections: **U.S.A. GEORGIA. Ben Hill Co.:** US-129 at S edge of Bowens Mill town limits, just N of GA-182, 7 Sep 2003, *J. Semple & B. Semple 11212* (WAT); S of Bowens Mill, US-129 0.4 km S of GA-182, 7 Sep 2003, *J. Semple & B. Semple 11216* (WAT); 8.2 mi N of Fitzgerald, sandhills by US-129, 25 Sep 1975, *Kral 56788* (MO, VDB). **Pulaski Co.:** W side of Hartford, US-341 0.9 km E of GA-26, just E of radio station, 7 Sep 2003, *J. Semple & B. Semple 11208* (WAT). **Richmond Co.:** Ft. Gordon Military Res., turkey oak sandhills, *S.B. Jones 15123* (USF). **SOUTH CAROLINA. Aiken Co.:** N of Graniteville, Interstate-20, embankment, road right-of-way, 8 Sep 2003, *J. Semple & B. Semple 11218* (WAT).

Solidago lepida DC. subsp. **fallax** (Fernald) Semple, stat. nov. BASIONYM: *Solidago lepida* DC. var. *fallax* Fernald, Rhodora 17:9–10. 1915. Fl. S. Brit. Columbia 301. 1915. *Solidago elongata* Nutt. var. *fallax* (Fernald) G.N. Jones, Univ. Wash. Publ. Biol. 5:242. 1936. *Solidago canadensis* L. var. *fallax* (Fernald) Beaudry, Naturaliste Canad. 95:37. 1968. TYPE: CANADA. NEWFLOUNDLAND: Harry's River, gravelly thicket, 18 Aug 1910, *Fernald & Wiegand 4108* (HOLOTYPE: GH!; ISOTYPE: NY photo!).

A discussion of all species in *Solidago* subsect. *Triplinervae* is in preparation to explain the taxonomic treatment of the subsection in Semple and Cook (submitted). In the treatment, *S. lepida* is the very sparsely to moderately glandular member of the subsection. Subspecies *lepida* is primarily a western taxon found from Alaska through the mountains to northern Californa and New Mexico and across northern Canada to Ontario and rarely to New Brunswick and the Gaspé, Québec. Subspecies *fallax* occurs in Newfoundland south to New Brunswick and rarely to northern Ontario. It has upper stems leaves with more numerous and larger serrations than occur on leaves of either var. *lepida* or var. *salebrosa* of subsp. *lepida*. Subspecies *fallax* is only very sparsely glandular with minute stipitate glands on the phyllary margins or tips.

Solidago lepida DC. var. **salebrosa** (Piper) J.C. Semple, comb. nov. BASIONYM: *Solidago serotina* Ait. var. *salebrosa* Piper in Piper & Beattie, Fl. Palouse Region, 185. 1901. *Solidago canadensis* L. var. *salebrosa* (Piper) M.E. Jones, Bull. Univ. Montana, Biol. ser. 15:49. 1910. *Solidago salebrosa* (Piper) Rydb., Fl. Rocky Mts. 870, 1067. 1917. *Solidago gigantea salebrosa* (Piper) Friesner, Butler Univ. Bot. Stud. 4:196. 1940. *Solidago gigantea* Ait. var. *salebrosa* (Piper) Friesner, Butler Univ. Bot. Stud. 5:113. 1941. *Solidago canadensis* L. ssp. *salebrosa* (Piper) Keck, Aliso, 4:104. 1958. TYPE: U.S.A. WASHINGTON: Pullman, Piper 1580 (HOLOTYPE: WS!; ISOTYPE: GH!)

Minute stipitate glands occurs on capitulescence structures (upper most stem leaves, bracts, peduncles and/or phyllaries) in *S. lepida* var. *salebrosa*, which differs from var. *lepida* in having arching, elongated lower branches in the capitulescence.

Solidago odora Aiton subsp. **chapmanii** (A. Gray) J.C. Semple, comb. nov. BASIONYM: *Solidago chapmanii* A. Gray, Proc. Amer. Acad. 16:80. 1880. *Solidago odora* Ait. var. *chapmanii* (A. Gray) Cronq., Brittonia 29:224. 1977. SYNTYPES: U.S.A. FLORIDA: "pine barrens, *Chapman s.n.* (GH!, NY photo!). Levy Co.: Nov 1877, *Dr. Gar-*

ber s.n. (GH!, LECTOTYPE, here designated; GH!, ISOLECTOTYPE, here designated). The Garber collections at GH are marked `n.sp. A. Gray'; the Chapman collection at GH is not. The Lectotype was selected because the label includes in Gray's hand "odorless form" and has heads in anthesis; its capitulescence has elongated lateral branches due to damage to the apex of the primary axis. The other Garber collection has two shoots, both with primarily fruiting heads.

Solidago patula Muhl. ex Willd. subsp. **strictula** (Torr. & A. Gray) J.C. Semple, stat. nov. BASIONYM: *Solidago patula* Muhl. var. *strictula* Torr. & A. Gray, Fl. N. Amer. 2:213. 1841. TYPE citation: "North Carolina! to Florida! and Louisiana!" SYNTYPES: U.S.A. LOUISIANA: *Drummond s.n.* (GH!, LECTOTYPE designated here because it is a more complete specimen; narrow-paniculate secund capitulescence and lower portion of stem with petiolate leaves, T. & G. FNA label annotated by Gray as "S. patula [beta] strictula"). *Hale s.n.* (GH!; narrow-paniculate capitulescence and portion of upper stem; on the same sheet with the Lectotype). Another collection by Drummond at GH has several labels: 1) "Jacksonville, Louisiana. T. Drummond. Hooker misit January 1835"; 2) "1870 Herb. From Herb J. Gay purchased by Dr. Hooker"; 3) "S. patula var. strictula" in Gray's hand on his SYN. FL. N. AMER. label; and 4) an annotation by Dr. G. Morton 1970 with the identification "*Solidago patula* Muhl." While this specimen was seen by Gray at some point, there is no indication it was seen before 1841 and, therefore, is rejected as a possible syntype.

Solidago puberula Nutt. subsp. **pulverulenta** (Nutt.) J.C. Semple, comb. et stat. nov. BASIONYM: *Solidago pulverulenta* Nutt., Gen. Pl. 161. 1818. non Bush (1918). *Solidago puberula* var. *pulverulenta* (Nutt.) Chapm., Fl. South. U.S. 210. 1860. TYPE: U.S.A. GEORGIA: s.d., *Nuttall s.n.* (HOLOTYPE: not seen; possible ISOTYPE: DH-122552!).

Solidago rugosa Mill. var. **cronquistiana** Semple, var. nov. (**Figs. 12–18**). TYPE: U.S.A. NORTH CAROLINA. Mitchell Co.: top of Roan Mt., 6250 ft. el., Forest Rd.-30 near parking lot, 15 Sep 1991, *Semple & Suripto 9666* (HOLOTYPE: WAT; ISOTYPES to be distributed: MO, NCU, NY).

Solidagini rugosi var. *asperi* accedens sed capitulescentia ramis brevibus foliis subtentibus nunc vix longioribus nunc brevioribus et caulibus sparsim hispidis differt.

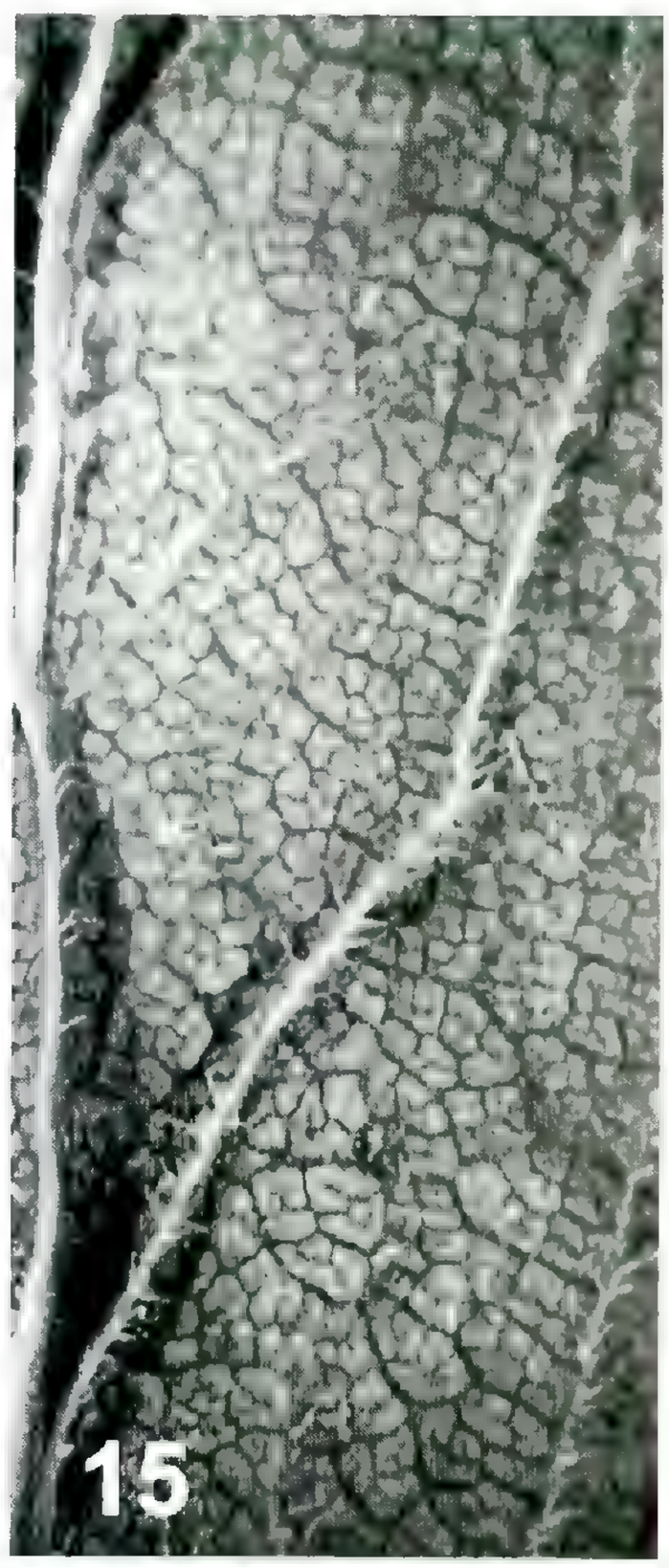
Solidago rugosa var. *cronquistiana* possesses a mixture of traits that are seen in both var. *aspera* and var. *rugosa* (the *villosa* morph). The leaves are usually strongly rugose like those of var. *aspera*, but not as densely hairy. The branches of the elongated capitulescence are usually short and more like those seen in morphs of var. *rugosa* traditionally assigned to the var. *villosa*, but lacking the dense pubescence of the latter. The lowest capitulescence branches of very robust plants can be elongated and repeat the pattern of the upper portion of the capitulescence (e.g. *Semple & Suripto 9829*); a similar phenomenon is seen in the virgate capitulescences of robust plants of other species of goldenrods such as *S. hispida* and *S. bicolor*. Based on field observations and knowledge of type material in *S. rugosa*, my first impression of the type collection made in 1991 was that it did not fit well into any previously described race of the *S. rugosa* complex. Additional collections were made in the Appalachian Mts. of North Carolina and extreme northern Georgia. The taxon likely also occurs at higher



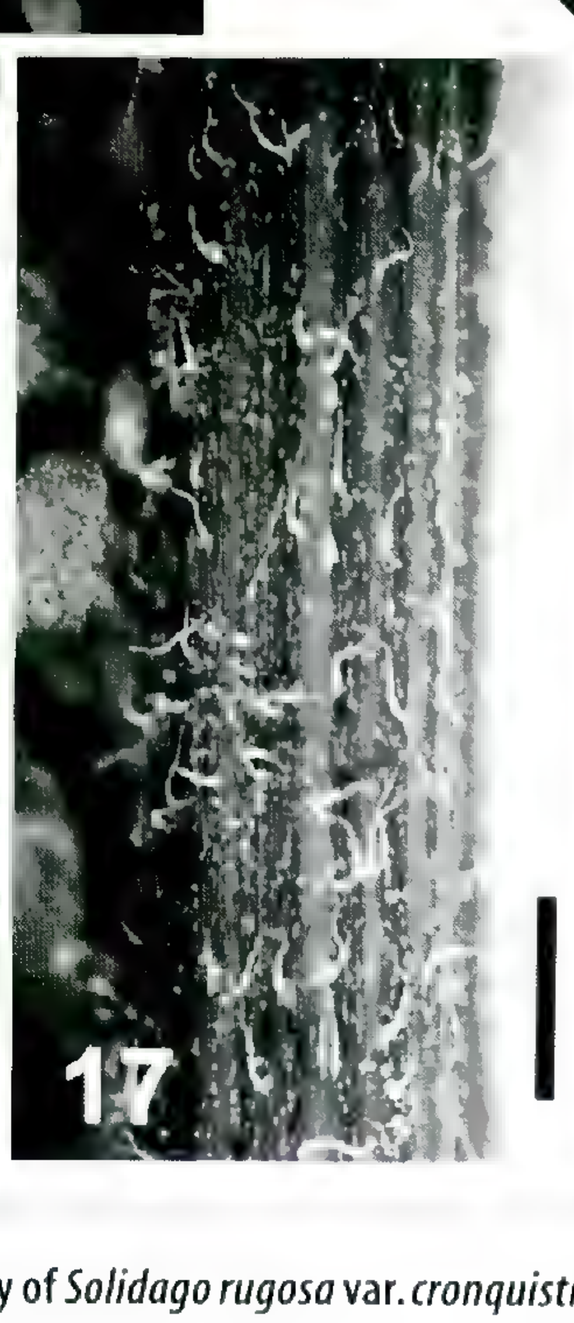
FIG. 12. Holotype of *Solidago rugosa* var. *cronquistiana, Semple & Suripto 9666* (WAT).

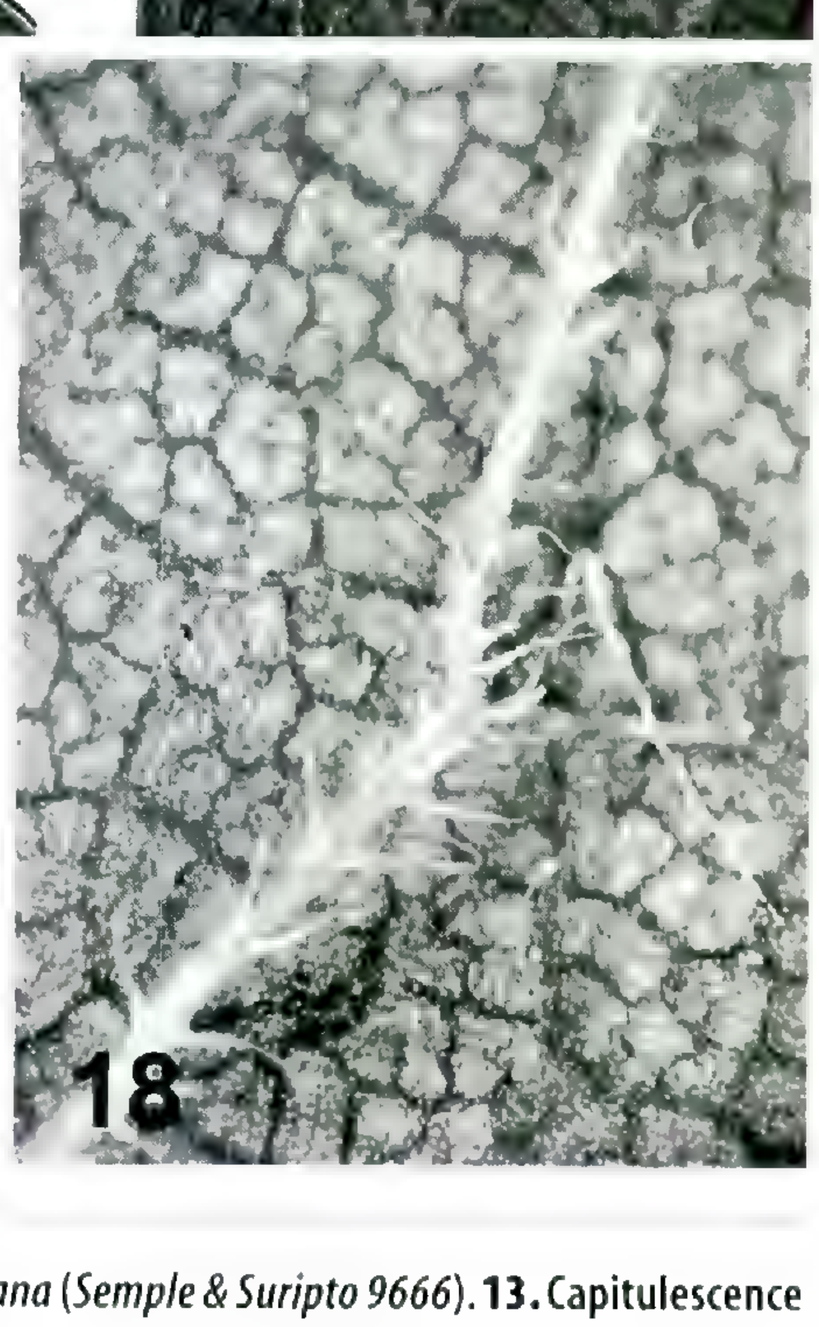












FIGS. 13–18. Details of the morphology of *Solidago rugosa* var. *cronquistiana* (*Semple & Suripto 9666*). **13.** Capitulescence of wild plant with wasp visitor. **14.** Mid stem leaf, abaxial surface. **15.** Detail of abaxial surface of upper mid stem leaf. **16.** Upper mid stem. **17.** Stem just below capitulescence. **18.** Enlarged area of lateral vein shown in 15. Scale bars in 16–17 equal 1 mm.

elevations in adjacent eastern Tennessee and western Virginia. All chromosome determinations made for the new variety were tetraploid. Overall, var. *cronquistiana* appears closer to var. *aspera* than to var. *rugosa* and is thus assigned to subsp. *aspera*.

The new variety is named in honor of the late Dr. Arthur Cronquist, whose work on composites is well known and whose occasional phone calls (usually at night or on weekends) on matters Astereae were both enlightening and entertaining.

Additional collections of var. *cronquistiana*: **GEORGIA. Rabun Co.:** GA-15 2 km N of Tallulah Falls, 21 Sep 1991, *Semple & Suripto 9828* (WAT). **NORTH CAROLINA. Avery Co.:** Beech Mountain, Beech Mt. Parkway just W of Red Oak Rd., 4 Sep 2002, *Semple 11131* (WAT); E of Linville, Grandfather Mt., ca. 5000 ft el., 15 Sep 1991, full sun, *Semple & Suripto 9674* (WAT); partial shade, *Semple & Suripto 9675* (WAT); US-221 S of Linville, 17 Sep 1991, *Semple & Suripto 9698* (WAT); between Linville and Roseborough, Roseborough Rd., E of Blue Ridge Parkway, 3 Sep 2002, *Semple & B. Semple 11120* (WAT). **Mitchell Co.:** top of Roan Mt., ca. 6260 ft el., Roan High Bluff Rd. (For.Rd.-130), 15 Sep 1991, *Semple & Suripto 9667* (WAT); 15 Oct 1999, *Semple 10808* (WAT). **Watauga Co.:** Deep Gap, US-221 just N of US-431, 5 Sep 2002, *Semple & B. Semple 11135* (WAT).

Collections of aff. var. *cronquistiana*: **U.S.A. GEORGIA. Rabun Co.:** GA-15 2 km N of Tallulah Falls, 21 Sep 1991, *Semple & Suripto 9829* (WAT, sample includes robust plants with elongated lower capitulescence branches). **NORTH CAROLINA. Wilkes Co.:** US-421 11.8 km E of Watauga Co. line, 17 Sep 1991, *Semple & Suripto 9707* (WAT, the capitulescence is damaged). Duplicates of *Semple* collections to be distributed.

Solidago sempervirens L. subsp. **azorica** (Hochst. ex Seubert) Semple, comb. et stat. nov. BASIONYM: *Solidago azorica* Hochstetten ex Seubert, Fl. Azor. 31. t. 10. 1844. *Solidago sempervirens* L. var. *azorica* (Hochst. ex Seubert) St. John, Rhodora 17:27. 1915. TYPE: AZORES, *Hochstetten 107* (not seen), St. Michael, s.d., *Hccnt? Esq. s.n.*, d.Schp-Bip. (GH!). The label is handwritten and difficult to read.

Solidago sempervirens L. subsp. **mexicana** (L.) Semple, comb. et stat. nov. BASIONYM: *Solidago mexicana* L., Sp. Pl. 879. 1753. non Kunth (1818), nec Berlandier ex DC. (1836). *Solidago sempervirens* L. var. *mexicana* (L.) Fern., Rhodora 37:447. 1935. SYNTYPES: Hort. *Clifford 409*, Solidago 1 (LECTOTYPE designated here if not done so previously: BM!). Herb. Linn. 998.13 [?] (LINN!). Both specimens are immature fragments and thus not ideal as type material for a taxon to be distinguished on the basis of mature head characteristics. The Clifford specimen is larger and more complete.

Solidago speciosa Nutt. subsp. **pallida** (Porter) Semple, comb. et stat. nov. BASIONYM: *Solidago speciosa* Nutt. var. *pallida* Porter, Bull. Torrey Bot. Club 19:130. 1892. *Solidago pallida* (Porter) Rydb., Bull. Torrey Bot. Club 33:153. 1906. SYNTYPES: U.S.A. COLORADO. [Jefferson Co.:] Bergen Park, Aug 1877, *E.L. Greene* (LECTOTYPE designated here: NY ex Columbia!). Canada: Mt. Mackay, Sep 1889, *Britton* (not seen; the subspecies does not occur in Canada).

Solidago stricta Aiton subsp. **gracillima** (Torr. & A. Gray) Semple, comb. et stat. nov. BASIONYM: *Solidago gracillima* Torr. & Gray, Fl. N. Amer. 2(2):215. 1842. SYNTYPES: U.S.A. FLORIDA: "middle," *Dr. Chapman s.n.* (LECTOTYPE, here designated: NY!; specimen with the capitulescence with three long secund branches;

ISOLECTOTYPES or just SYNTYPES if not duplicates of the lectotype collection: KEW(2)!, NY!). Chapman collection labels often lack sufficient information to determine which specimens from the same location are duplicates of a single collection or unicates of separate collections.

Solidago velutina DC. subsp. **californica** (Nutt.) Semple, comb. et stat. nov. BASIONYM: *Solidago californica* Nutt., Trans. Amer. Phil. Soc. n.s. 7:328. TYPE: U.S.A. CALIFORNIA: Santa Barbara, *Nuttall s.n.* (HOLOTYPE: BM!).

Solidago velutina DC. subsp. **sparsiflora** (A. Gray) Semple, comb. et stat. nov. BASIONYM: *Solidago sparsiflora* A. Gray, Proc. Amer. Acad. 12:58. 1877. TYPE: U.S.A. ARIZONA: near Camp Lowell, 1874, *Rothrock 706* (HOLOTYPE: GH!).

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PAPPUS VARIATION IN *SOLIDAGO* (ASTERACEAE: ASTEREAE)

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ABSTRACT

The pappus in the goldenrod genus *Solidago* (Asteraceae: Astereae) was examined in 75 species and compared with variation in 14 species of 12 related genera in subtribe Solidagininae in the narrow sense following Nesom (2000) and three species of asters of two genera basal to the North American Clade of the tribe. *Solidago* has been described as having a simple pappus consisting of one whorl of barbellate bristles with the exception of a few species in several sections, sometimes treated as distinct genera. Species of *Solidago* sect. *Corymbosae* (*Oligoneuron*) have long been recognized as having a biseriate pappus with clavate bristles similar to that of other genera of the subtribe. However, nearly all species of *Solidago* displayed some evidence indicating the pappus bristles occur in two more or less heteromorphic whorls of bristles, here designated as the primary outer whorl and the primary inner whorl. A few species also occasionally had a third, much shorter secondary outer whorl of a few bristles. In the most heteromorphic species, the primary outer whorl of bristles was slightly shorter and had tips that gradually tapered. The primary inner whorl of slightly longer bristles had distinctly clavate tips up to several times as broad as the bristle below the tip. As well, the bases of the primary outer whorl were clearly external to those of the primary inner clavate whorl in some species. In contrast, most species in several subsections of the genus exhibited little evidence of a biseriate pappus or clavate bristle tips. The pappus of each species was scored on several traits: 1) non-clavate to distinctly clavate bristle tips, 2) evidence of alternating non-clavate and clavate bristles or shorter and longer bristles, and 3) evidence of overlapping primary outer and inner whorls of bristles. One species of *Solidago* had an atypically short pappus; the bristles of *S. sphacelata* were less than half the length of the cypsela body. The biseriate pappus of *Brintonia discoidea* was usually tinted with anthocyanotic pigments unlike any species of *Solidago*; the species has been included in *Solidago* by some authors.

RESUMEN

Se examinó el vilano en 75 especies del género *Solidago* (Asteraceae: Astereae) y se comparó con la variación en 14 especies de 12 géneros relacionados de la subtribu Solidagininae en sentido restringido según Nesom (2000) y tres especies de asteráceas de dos géneros basales al clado Norte Americano de la tribu. *Solidago* se ha descrito como poseedor de un vilano simple que consiste en un verticilo de sedas barbeladas, con la excepción de unas pocas especies en varias secciones, a veces tratadas como géneros diferentes. Las especies de *Solidago* sect. *Corymbosae* (*Oligoneuron*) han sido reconocidas por presentar un vilano biseriado con sedas clavadas similares a las de otros géneros de la subtribu. Sin embargo, casi todas las especies de *Solidago* muestran algunas pruebas que indican que las sedas del vilano se sitúan en dos verticilos más o menos heteromórficos, que aquí se nombran como verticilo primario externo y verticilo primario interno. Unas pocas especies también tienen ocasionalmente un tercer verticilo, el verticilo secundario externo, mucho más corto y de unas pocas sedas. En la

[1]Author of correspondence.

especie más heteromórfica, el verticilo primario externo de sedas era ligeramente más corto y tenía extremos gradualmente afilados. El verticilo primario interno, de sedas ligeramente más largas, tiene extremos claramente clavados de hasta varias veces más anchos que la propia seda debajo del extremo. Así mismo, las bases del verticilo primario externo eran claramente externas a las del verticilo primario interno clavado en algunas especies. Por contra, la mayoría de las especies de varias subsecciones del género mostraban pocas pruebas de un vilano biseriado o de extremos de las sedas clavados. El vilano de las distintas especies fue escrutado en varios aspectos: 1) extremos de las sedas de no-clavadas a distintamente clavadas, 2) evidencia de alternancia de sedas no-clavadas y clavadas o sedas más cortas y más largas, y 3) evidencia de solapamiento de los verticilos de sedas primario externo e interno. Una especie de *Solidago* tenía un vilano atípicamente corto; las sedas de *S. sphacelata* eran menos de la mitad de la longitud del cuerpo de la cipsela. El vilano biseriado de de *Brintonia discoidea* estaba normalmente teñido con pigmentos antociánicos, cosa que no ocurre en las especies de *Solidago*; la especie ha sido incluida en *Solidago* por algunos autores.

INTRODUCTION

Previously the genus *Solidago* L. was considered different from closely related genera in regards to its pappus characteristics. While related taxa such as *Sericocarpus* Nees, *Tonestus* A. Nels., *Petradoria* E.L. Greene, *Chrysothamnus* Nutt. and *Ericameria* Nutt. were considered to have a pappus in 2–3 series (1–2 for *Tonestus*), the genus *Solidago* was stated to have a pappus in a single series (e.g., Semple et al. 1999; Nesom 2000). It has also been described as simple (Fernald 1950; Correll et al. 1970). Some treatments do not mention anything about the seriate nature of the pappus in the genus description (Radford et al. 1968; Cronquist, 1980; Gleason and Cronquist 1991), although variations are indicated in species descriptions. Some treatments state that the pappus of *Solidago* exhibits some variation. Gleason and Cronquist (1991) recorded the pappus as being "of numerous equal or sometimes unequal capillary bristles" for species from the northeast U.S.A. and adjacent Canada, while Cronquist (1994) noted the pappus as being "equal or sometimes somewhat unequal" in Great Basin species. Some of the differences in description are due to differences in which taxa were included in the genus *Solidago*, particularly the generally recognized clavate tipped members of *Solidago* sect. *Corymbosae* Torrey & A. Gray. For example, Cronquist (1980) included these flat-topped goldenrods, but excluded *Brintonia discoidea* (Elliott) E.L. Greene, the Mock Goldenrod. In contrast, Nesom (2000) excluded the former species placing them in the genus *Oligoneuron* Small, but included *Brintonia discoidea* as *S. discoidea* (Elliott) Torrey & A. Gray. Nesom (1991) discussed morphological reasons for treating *B. discoidea* within *Solidago*. Semple (submittted) treated *Brintonia* as a separate genus based on morphology (phyllary traits, disc corolla traits, pappus traits), field observations and DNA studies (Beck and colleagues, pers. comm.). *Solidago sphacelata* Raf. has been treated as *Brachychaeta sphacelata* (Raf.) Britt. due to its distinctive short pappus, but the general consensus recently is to retain it within *Solidago* (Cronquist 1980; Nesom 1991, 1993; Semple and Cook, submitted). Other authors in the past have included *Euthamia* (Nutt.) Nutt.,

Oreochrysum Rydberg, or *Petradoria* in *Solidago*, there by increasing the range of variation in pappus traits within the latter genus (e.g., Fernald 1950; Kearney & Peebles 1951; Harrington 1964; Semple et al. 1999).

The details of pappus bristle shape have generally been overlooked and descriptions have included various terms. Most have described the pappus of *Solidago* as "capillary" or "hair-like" (Fernald 1950; Radford et al. 1968; Correll & Johnston 1970; Cronquist 1980, 1994; Gleason & Cronquist 1991). Some treatments mention the pappus of *Solidago* as being "barbellate" or "clavate" in some species (Cronquist 1980, *S. ptarmicoides* (Torrey & A. Gray) Boivin; Semple et al. 1999, *S. houghtonii* Torrey & A. Gray, *S. ptarmicoides* (as *S. asteroides* Semple), *S. sempervirens* L.). Pappus bristles of *Solidago* and closely genera have been described as being "barbellate" (Nesom 2000). Nesom (1993) in his overview of *Solidago* and *Oligoneuron* used pappus bristle apex features as taxonomic characters: "strongly clavate," "attenuate," and "slightly but distinctly dilated toward the apex." He listed these in descriptions of sections and subsections, and noted the character state of pappus bristles for some species in particular.

The occurrence of a biseriate to multiseriate pappus has long been reported in other genera in the Tribe Astereae in both the North American Clade, which includes *Solidago* (see Semple et al. 2002), and the Basal Grade of South American and Old World Genera. The more basal genera in the North American Clade are biseriate or triseriate with bristles of equal or different lengths. These include most of the genera included traditionally in the Old World genus *Aster* L.: *Doellingeria* Nees, *Eucephalus* Nutt., *Ionactis* E.L. Greene, *Oclemena* E.L. Greene, *Sericocarpus*. Most species in subtribe Chrysopsidinae Nesom are biseriate, having a short outer whorl and a much longer inner whorl. In contrast, the pappus of some genera is typically uniseriate, e.g. *Symphyotrichum* Nees. In some cases the usual barbellate bristles are absent or very reduced, e.g. ray floret cypselae of *Heterotheca* sect. *Heterotheca*, *Aphanostephus* DC. The number of bristles varies greatly between species within and between genera as well. Thus, within the North American Clade of genera of Astereae there exists a range in the number of whorls, their relative lengths and their shapes (see Nesom 2000 for general descriptions of genera). No detailed systematic examination of the pappus of most or all species of *Solidago* has been reported. Our study was undertaken to fill in this gap in knowledge.

MATERIALS AND METHODS

A preliminary survey was undertaken to examine under the dissecting microscope the pappus bristles of one or two specimens of representative species of the sections and subsections of *Solidago*. Subsequently, a more rigorous survey was conducted involving 75 species of *Solidago* and 17 species of 14 other genera listed in Table 1. Two methods of observation were employed, and a system of ranking the degree of the clavateness of bristle tips was developed. Most ob-

TABLE 1. Pappus characteristics of *Solidago* taxa and related genera.

Taxon	Clavate[1]	Alternating	Overlapping	Comments
SOLIDAGO* L. sect. *SOLIDAGO				
subsect. ***Solidago***				
S. virgaurea	3	Yes	Yes (random)	
subsect. ***Multiradiatae*** (Juzepczuk) Semple				
S. cutleri	3	Yes	Yes (slight)	
S. multiradiata	2	Yes	Yes (slight)	
S. spithamea	2	Yes	Yes	
subsect. ***Humiles*** (Rydberg) Semple				
S. arenicola	4	Yes	Yes (random)	
S. kralii	4	Yes	Yes (slight)	short obscure secondary outer whorl
S. plumosa	1	Yes	Yes (random)	
S. simplex	3	Yes	Yes (random)	
S. spathulata	1	Yes	Yes (random)	
subsect. ***Thyrsiflorae*** (A. Gray) Nesom				
S. buckleyi	4	Yes	Yes	thickened length
S. hintoniorum	2	Yes	Yes	much overlapping of bases
S. orientalis	3	Yes	Yes	much overlapping of bases
S. petiolaris	3	Yes	Yes (slight)	
S. wrightii	2	Yes	Yes (random)	
subsect. ***Albigula*** (Raf.) Nesom				
S. bicolor	4	Yes	Yes	Overlapping very distinct in places
S. erecta	4	Yes	Yes	possible secondary outer whorl, very thickened tips
S. hispida	3	Yes	Yes (slight)	
S. puberula	3	Yes	Yes	
S. roanensis	2	Yes	Yes (random)	
S. sciaphila	3	Yes	Yes	
S. speciosa	4	Yes	Yes	
S. squarrosa	3	Yes	Yes (random)	bristles highly crowded at base
subsect. ***Glomeruliflorae*** (Torrey & A. Gray) Nesom				
S. albopilosa	3	Yes	No	
S. caesia	2	Yes	Yes (slight)	
S. curtisii	3	Yes	No	
S. flexicaulis	3	Yes	Yes	
S. glomerata	3	Yes	Yes (slight)	
S. lancifolia	3	Yes	Yes (slight)	
S. macrophylla	2	Yes	No	very large cypselae
subsect. ***Argutae*** (Mackenzie) Nesom				
ser. ***Argutae*** (Mackenzie in Small) Nesom				
S. arguta	4	Yes	Yes (random)	seemingly short pappus
S. fauciba	2	Yes	Yes (slight)	
S. ludoviciana	2	Yes	Yes (slight)	
S. patula	2	Yes	Yes	

Taxon	Clavate[1]	Alternating	Overlapping	Comments
ser. ***Auriculatae*** Semple				
S. auriculata	3	Yes	Yes	
ser. ***Brachychaeta*** (Torrey & A. Gray) Nesom				
S. sphacelata	1	Yes	No	very reduced; alternating very short and short bristles
subsect. ***Junceae*** (Rydberg) Nesom				
S. confinis	1	Yes	Yes	thick bristles, long-short alternation, pronounced overlap
S. gattingeri	0	Yes	No	
S. guiradonis	2	Yes	Yes	
S. juncea	1	Yes	No	
S. missouriensis	0	Yes	No	long-short alternation, some longer bristles are thicker
S. pinetorum	1	Yes	No	
S. spectabilis	1–2	Yes	No	thickened tips, crowding at base
subsect. ***Maritimae*** (Torrey & A. Gray) A. Gray				
S. sempervirens	2	Yes	Yes	reduced secondary outer whorl (subsp. *sempervirens* and *mexicana*)
S. stricta	2	Yes	Yes	(subsp. *stricta* and *gracillima*)
S. pulchra	2	Yes	Yes (slight)	thickened length, very reduced secondary outer whorl
S. uliginosa	1	Yes	Yes (slight)	
subsect. ***Venosae*** (G. Don in Loudon) Nesom				
ser. ***Venosae***				
S. ulmifolia	0	Yes	Yes	overlapping very distinct at times; alternating short and long bristles
S. delicatula	1	Yes	Yes (random)	
S. latissimifolia	1	Yes	Yes (slight)	some prominent overlap at base of whorls
S. rugosa	1	Yes	No	
S. fistulosa	1	Yes	No	crowding at base
ser. ***Odorae*** (Mackenzie) Semple				
S. odora	2	Yes	Yes	long-short alternation, strong overlap, possible secondary outer whorl
subsect. ***Triplinervae*** (Torrey & A. Gray) A. Gray				
S. altiplanities	1–2	Yes	Yes (slight)	
S. altissima	0	No	No	possibly alternating, but only very weakly (both subspecies)
S. canadensis	0	No	No	possibly alternating, but only very weakly

TABLE **1.** cont.

Taxon	Clavate[1]	Alternating	Overlapping	Comments
S. elongata	2	Yes	Yes (random)	
S. gigantea	0	No	No	
S. juliae	1	Yes	Yes (random)	
S. leavenworthii	1	Yes	Yes (random)	
S. lepida				
subsp. *fallax*	1	Yes	No	
subsp. *lepida*	1	Yes	No	(var. *lepida* and var. *salebrosa*)
S. muelleri	1	Yes	No	
S. shortii	2	Yes	Yes (slight)	
S. tortifolia	0	Yes	No	
subsect. ***Nemorales*** (Mackenzie) Nesom				
S. nana	3	Yes	Yes	
S. nemoralis	1	Yes	No	(subsp. *nemoralis* and *decemflora*)
S. mollis	2	Yes	No	
S. radula	2–3	Yes	No	
S. velutina				
subsp. *californica*	2	Yes	No	
subsp. *sparsiflora*	1–2	Yes	Yes (slight)	
subsp. *velutina*	2	Yes	Yes (slight)	
***SOLIDAGO* L. sect. *CORYMBOSAE* Torrey & A. Gray**				
S. houghtonii	2	Yes	Yes	
S. nitida	3	Yes	Yes	
S. ohioensis	3	Yes	Yes	
S. ptarmicoides	4	Yes	Yes	
S. riddellii	2	Yes	Yes	
S. rigida	2	Yes	Yes	strong overlapping (subsp. *rigida*, *humilis*, and *glabrata*)
placement uncertain				
S. ericamerioides	2	Yes	Yes (slight)	
Some Other Genera of the Solidagininae sensu Nesom (2000)				
Brintonia discoidea[2]	3	Yes	Yes (slight)	bristles tinted with anthocyanins; biseriate pappus
Chrysoma pauciflosculosa	2	Yes	Yes	strong overlapping; secondary outer whorl of much shorter tapering bristles; primary outer whorl slightly shorter bristles tapering to weakly clavate; primary inner whorl of longer somewhat clavate bristles

Taxon	Clavate[1]	Alternating	Overlapping	Comments
Chrysothamnus viscidiflorus	1	Yes	Yes	obvious biseriate pappus
Ericameria laricifolia	3	Yes	Yes	obvious biseriate pappus
Ericameria discoideum	1	Yes	Yes	biseriate pappus
Euthamia graminifolia	0	Yes	No	variation in bristle length obscures weak pattern of short-long alternation of bristles
Gundlachia corymbosa	0–2	Yes	No	weakly biseriate with the two whorls alternating; primary outer slightly shorter, tapering; primary inner longer, weakly clavate
Gutierrezia sarothrae	0	No	No	crown of irregular some-what erose scales of varying lengths and widths
Hesperadoria scopulorum	1	Yes	Yes	multiiseriate pappus; primary whorls of many Longer bristles, one shorter outer secondary whorl of fewer bristles
Oreochrysum parryi	1	Yes	Yes (slight)	
Petradoria pumila	1	Yes	Yes	obvious biseriate pappus
Sericocarpus				
S. linifolia	4	Yes	Yes	obvious biseriate pappus; outer whorl slightly shorter than inner
S. oregonensis	4	Yes	No	possible slight overlapping at base of whorls
Tonestus pygmaeus	4	Yes	Yes	
Genera Basal to the North American Clade				
Doellingeria umbellata	3	Yes	Yes	triseriate; short outer third whorl
Eucephalus				
E. breweri	2	Yes	Yes	triseriate pappus
E. elegans	4	Yes	Yes	biseriate, possible weakly triseriate

[1] arbitrary ranking of 0 (not clavate) to 4 (strongly clavate)

[2] treated as *Solidago discoidea* by Nesom (1993)

servations were made using a dissecting scope or a compound light microscope. Some observations were made using dried and gold coated specimens on a Hitachi S-570 Scanning Electron Microscope (SEM). At least five different fruits from each species were observed under the dissecting microscope at a maximum of 70×; most observations were made at 30×. In some cases multiple dozens of specimens of a species were examined. For the most part, observations were made on specimens in the WAT Herbarium, but additional material on loan from BRIT, F, GH, JEPS, NY, TEX and UC (Holmgren et al. 1990) was also examined.

Observations on the compound microscope were made from slides prepared as follows. For each species, two ray floret and two disc floret cypselae with corollas were mounted in DepeX mounting medium under a cover slip. Observations at 100× on the compound microscope were made similarly to the observations under the dissecting scope at 30×–70×. Observations made on the two kinds of scopes were compared and any discrepancies were resolved by re-examining specimens.

Each taxon was scored in the following manner:

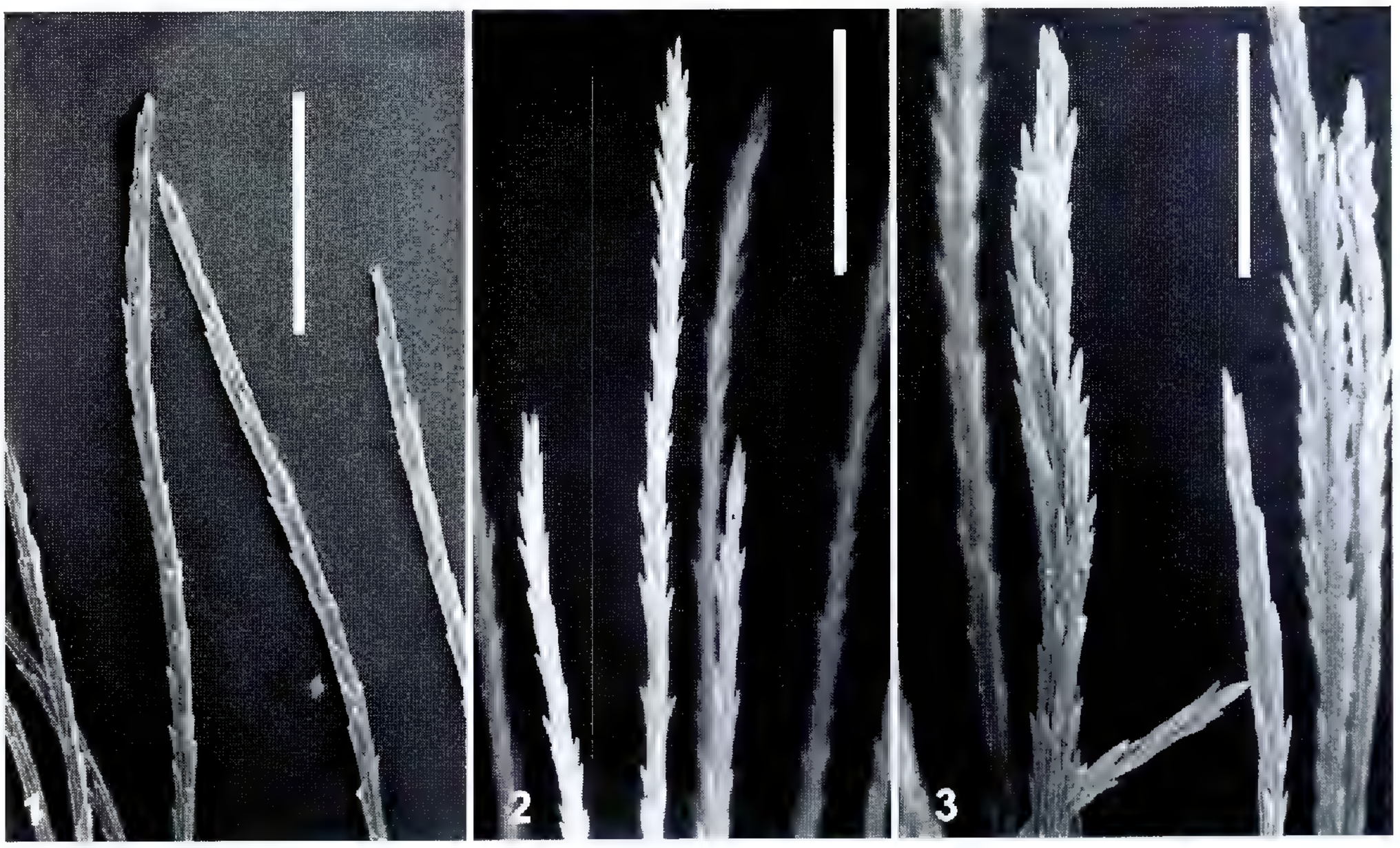
1. Cypselae were assigned a number from 0–4 depending on the thickness of the tip of the bristle in relation to the thickness along the length: 0 = no observable increase in thickness and the bristles tapered to a point (Fig. 1); 1 = a very slight increase in thickness near the tip, or the bristles not tapering gradually; 2 = a slight to moderate increase in thickness near the tip (Fig. 2); 3 = a strong and obvious presence of clavate tips; and 4 = very noticeable increase in thickness, very obvious clavate nature of the bristles (Fig. 3). A set of reference light-microscopy photomicrographs were used to maintain consistency in assigning values.

2. Cypselae were scored as showing no evidence of alternation of primary inner and outer whorls of bristles or as showing evidence of alternating with the notes on the nature of the alternation (No or Yes in Table 1, respectively).

3. Cypselae were scored for evidence of overlapping at the bases of the outer and inner whorls of bristles. The taxa examined were graded in three categories regarding the overlapping of the bristles at the base: Yes = complete overlap of bristles; Yes (slight) = slightly overlapping with outer whorl bristles consistently appearing external to inner whorl bristles; and Yes (random) = overlapping of some outer bristles external to inner bristles but not consistently so for the two whorls.

4. Notes were made when a secondary outer whorl (a third whorl) of very short barbellate bristles was observed. Such bristles were not easily observed and occurred in low numbers, thus the presence or absence of such bristles was not tabulated.

Digital photomicrographs were taken using a Nikon CoolPix 990 camera manually held against the ocular lens of either the dissecting or compound



FIGS. 1–3. Pappus bristle tip variation in *Solidago*; scanning electron micrographs, scale bar = 0.3 mm. **1.** Non-clavate bristle tip, *S. pinetorum* (0 value in Table 1). **2.** Weakly clavate bristle tip, *S. odora* (2 value in Table 1). **3.** Strongly clavate bristle tip, *S. erecta* (4 value in Table 1).

microscope. Pictures were taken of specimens under the compound light microscope with either below stage or above stage lighting. SEM photomicrographs were made using Ilform Pan F film commercially developed and subsequently digitized by scanning the negatives. Final digital illustrations were made using CorelDraw 10® from digital images edited with Corel PhotoPaint10® (Corel Corp.).

RESULTS AND DISCUSSION

The lack of a standard set of terms for pappus bristle whorls in *Solidago* and other genera lead to some confusion in discussing the results between the authors and for the reviewer. The following labels are presented as potential future "standard" terms for discussing pappus whorls in the Astereae. Because a biseriate pappus is found in many genera of the tribe, we recommend that these two whorls of bristles be referred to as the "primary outer whorl" and the "primary inner whorl." The primary inner whorl often is longer and has slightly to strongly clavate bristle tips. The third, often much shorter, outer whorl present in some genera can be referred to as the "secondary outer whorl." These labels for bristle whorls are used consistently throughout this paper. The term "secondary" with appropriate modifiers can be applied to any additions whorls, e.g. a secondary innermost whorl of non-clavate long bristles.

The pappus of the genus *Solidago* is usually biseriate, although obscurely so in some species. In most species the pappus exhibited either alternation of

shorter and longer bristles, alternation of clavate and non-clavate bristles, or some degree of basal overlapping of outer and inner bristles of the primary inner and outer whorls. Table 1 lists observations on the degree of clavateness of bristle tips, presence or absence of evidence of alternation of whorls of bristles, degree of basal overlapping of outer and inner long whorls, and specific observations on 75 species of *Solidago* and 17 species of 14 related genera. Species of *Solidago* are grouped within Table 1 by section, subsection and series following the treatment of the genus by Semple (Semple et al. 1999; Semple 2003; Semple, submitted; Cook and Semple, submitted, treatment of *Solidago* for Flora North America). There is a large range in size of the cypselae bodies and length of the pappus bristles among species of *Solidago* (Figs. 4–9). Bristles can be much shorter than to four times longer than the fruit body, and bristle length ranged from 0.25–7.5 mm. Cypsela bodies varied from 0.5–5 mm in length and from glabrous to densely short strigose. The number of bristles per cypsela ranged from about 25 (Fig. 9 , *S. canadensis*) to more than 40 (Fig. 6, *S. auriculata*). On average, pappus bristles were slightly shorter than the disc corollas (averaging about 9/10 as long comparing the mature pappus to the disc corolla length at anthesis based on data in Semple and Cook, submitted).

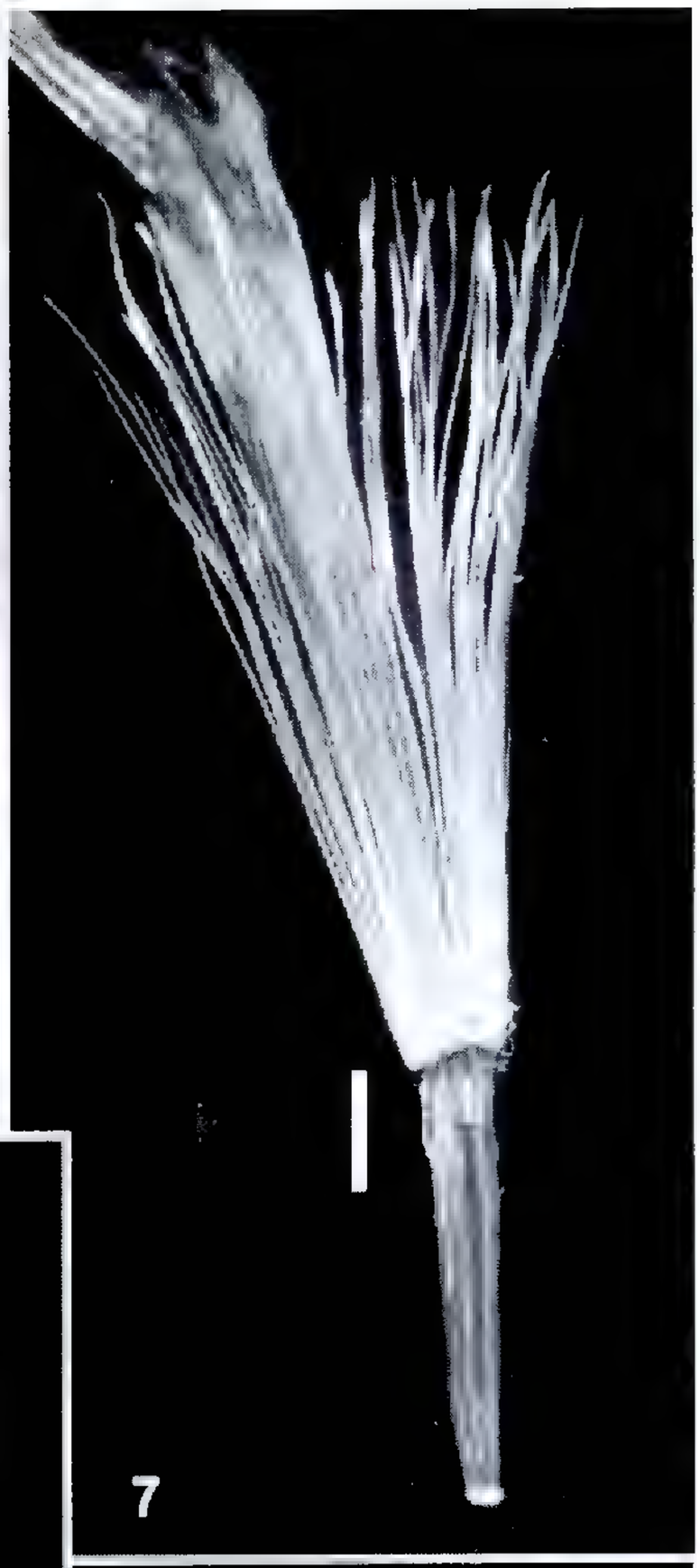
Some of the pappus bristles in the majority of species of *Solidago* were observed to be more or less clavate, and these were the primary inner whorl bristles in taxa where position of the whorls could be determined. About 25% of the species examined had, relative to other species, broad clavate bristle tips on the primary inner whorl of bristles, e.g., *S. auriculata* (Fig. 6), *S. erecta* and *S. arguta*. Almost all species exhibited some indication of alternating clavate bristles and non-clavate bristles (Fig. 6), and some exhibited alternating between short bristles and long bristles, e.g. *S. ulmifolia*, (Fig. 13). Alternation of short and long bristles indicated a biseriate pappus even if little difference was observed in tip traits of the two whorls. Variation in the pappus of each species was observed but was of limited range; that is, bristles of a whorl could vary from scores of 0–2 or 3–4 for degree of clavateness, but not to the degree that some fruits had only non-clavate bristles while others of the same species had only strongly clavate bristles.

Some species had very clear overlapping of the bases of the primary whorls of bristles, e.g. *S. rigida* (Fig. 10) and *S. odora* (Fig. 12), while others (e.g., *S. bicolor* and *S. ulmifolia*) clearly had overlapping of some bases of the pappus bristles while other bristles on the same fruit did not appear to be overlapping. Many other species exhibited only slight overlapping of the bristle bases (e.g., *S. glomerata* and *S. multiradiata*) or random overlapping of some bristle bases but not in a clear primary inner whorl and primary outer whorl pattern. (e.g., *S. leavenworthii* and *S. simplex*). Some species appeared to have no overlapping bases, e.g. *S. altissima* (Fig. 11).

Some species of *Solidago* had a third, much reduced, secondary outer whorl

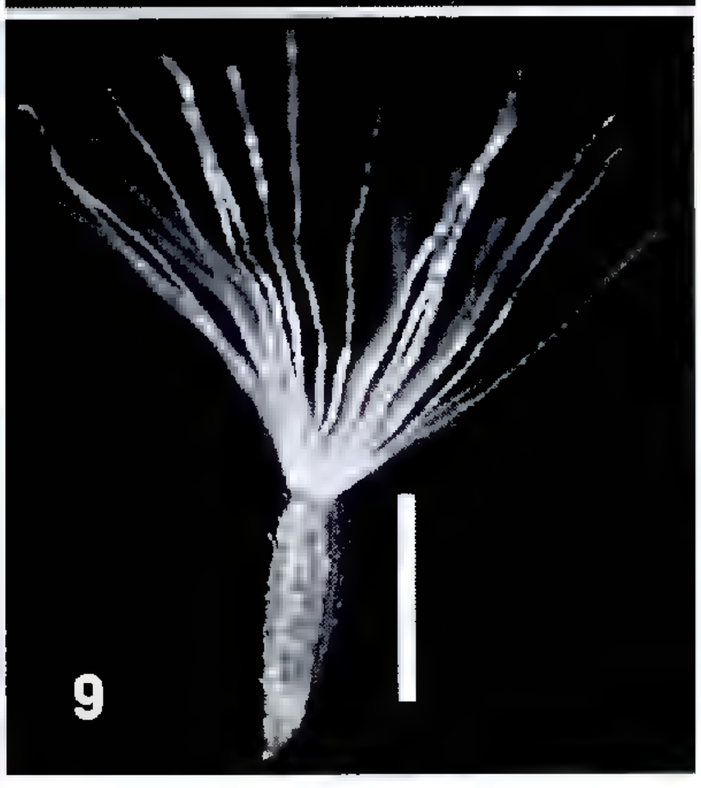






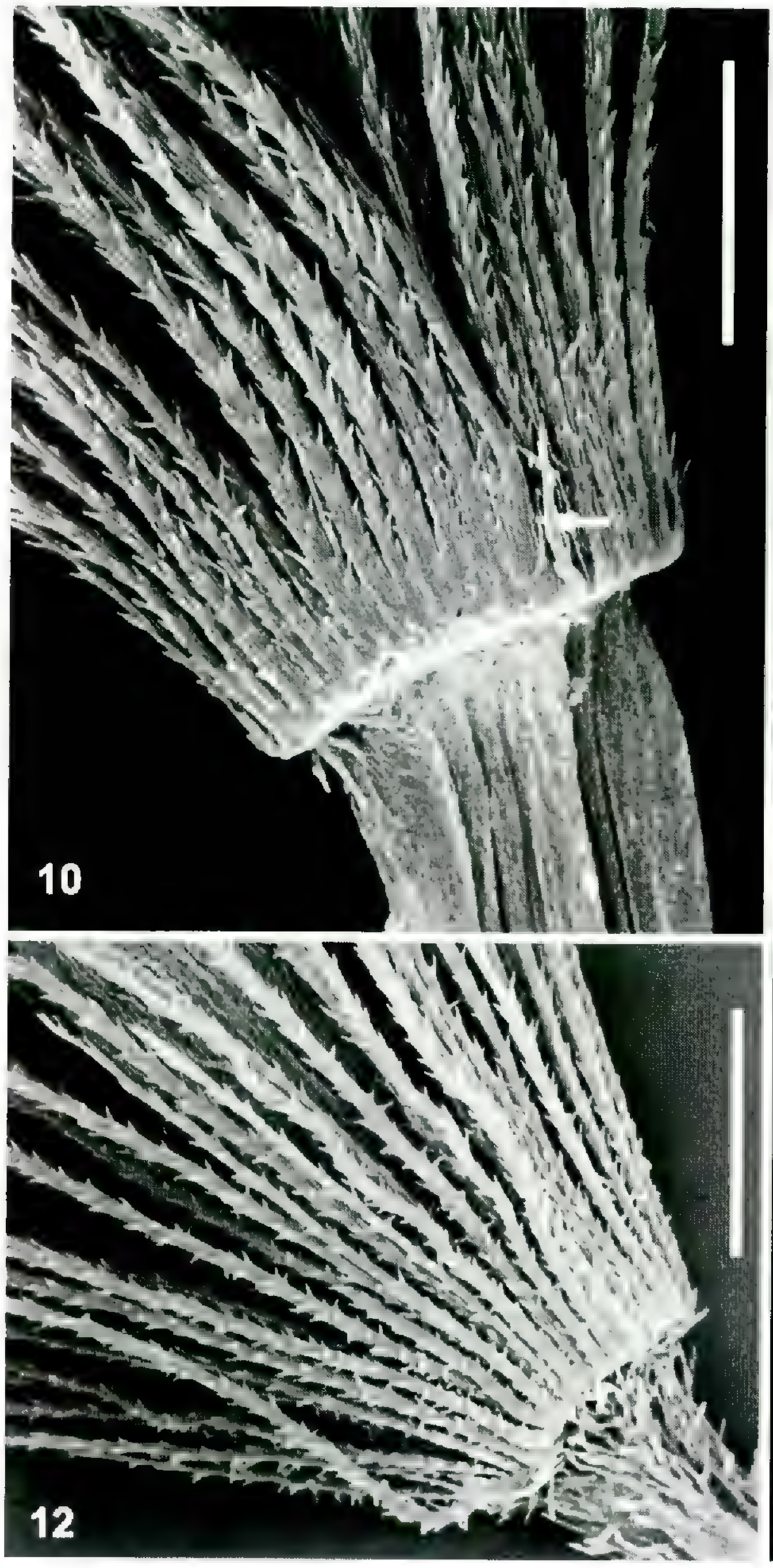


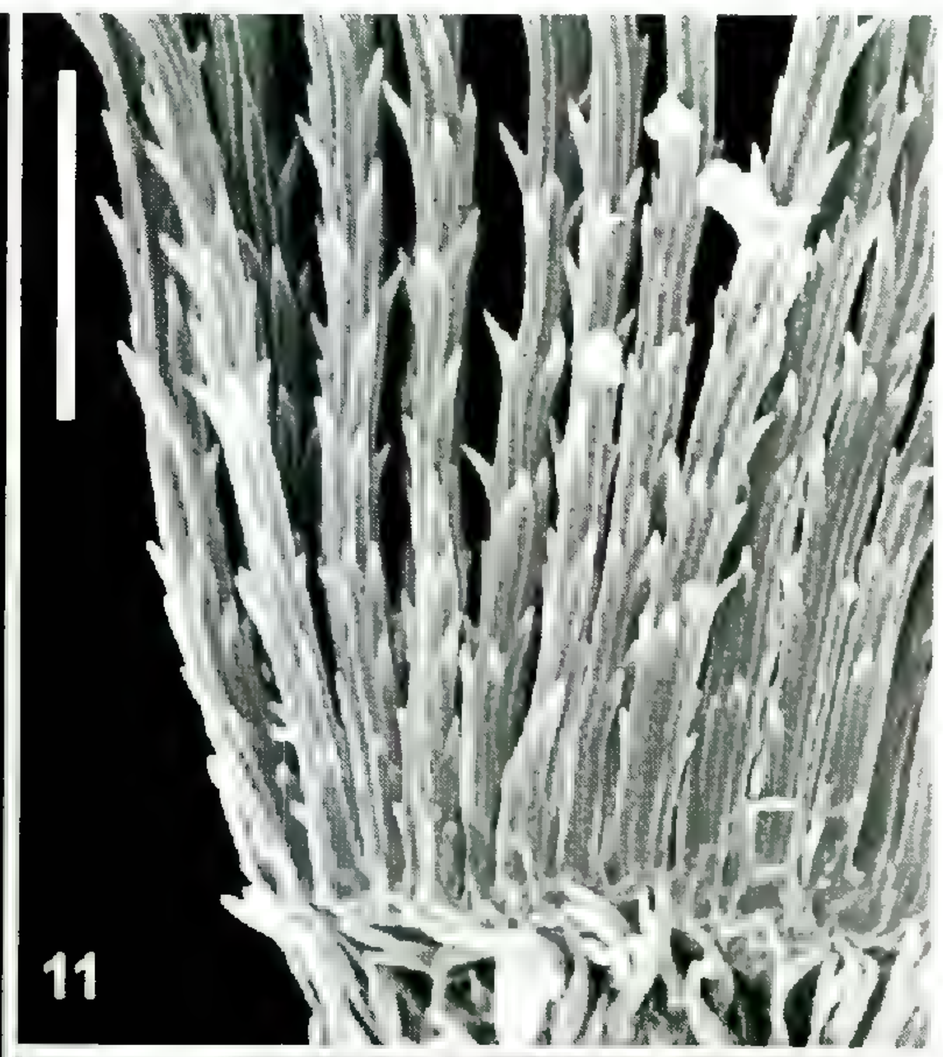


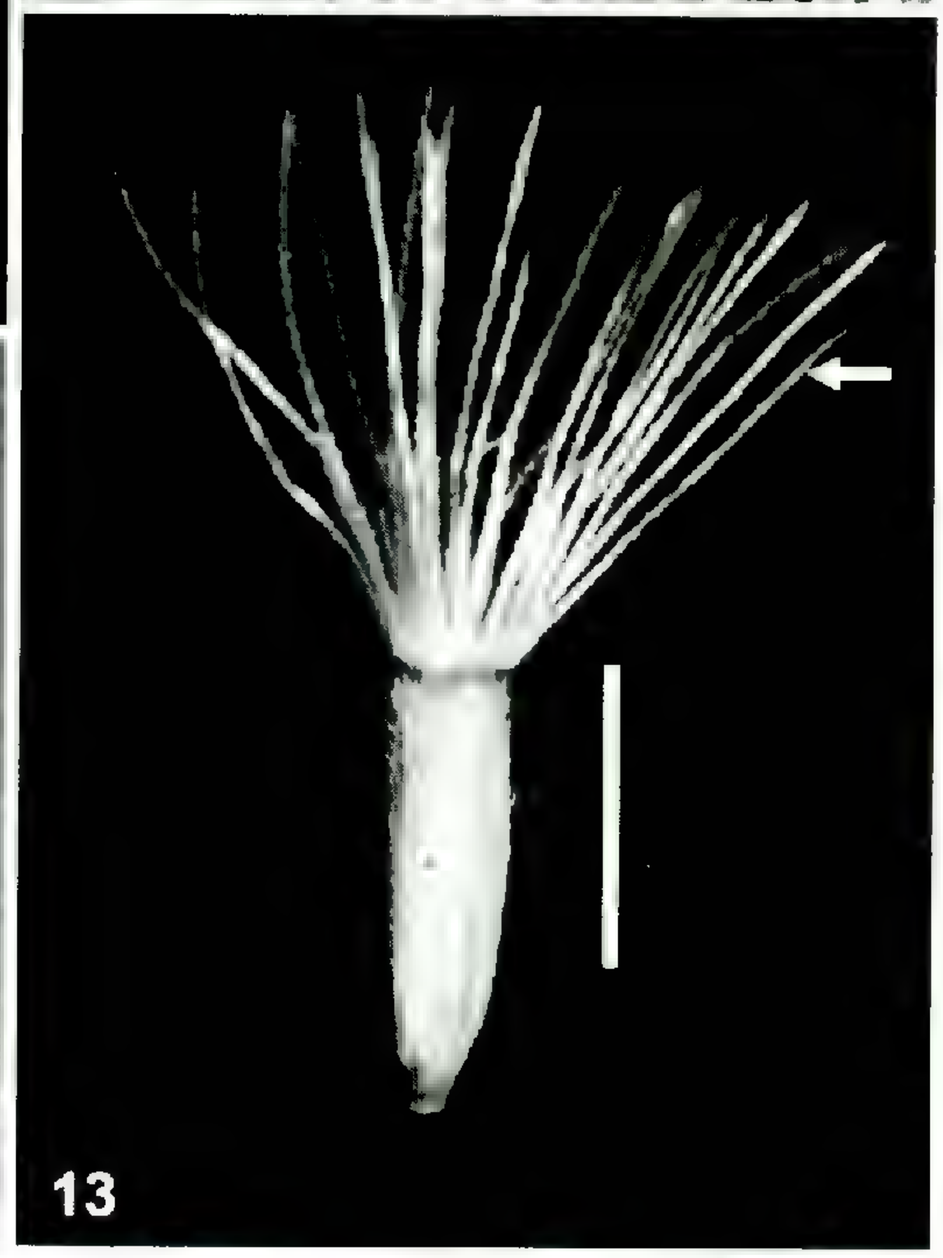


FIGS. 4–9. Length and number variation pappus bristles in *Solidago*; white scale bar = 1 mm. **4–5.** *Solidago sphacelata*, immature and mature cysellae, respectively. **6.** *Solidago auriculata*, maturing cypsela with disc corolla attached, scale bar = 1 mm. **7–8.** *Solidago macrophylla*, immature and mature cypselae, respectively. **9.** *Solidago canadensis*, mature cypsela.

of a few short barbellate bristles: e.g., *S. erecta* and *S. kralii*, *S. rigida* (Fig. 10) and *S. sempervirens*. This condition was difficult to observe and required searching at 70–100×. As noted in the Materials and Methods, detection of the presence of a third whorl was difficult because the few small bristles making up







FIGS. 10–13. Variation in pappus bristle whorls in *Solidago* (scanning electron micrographs). **10.** Biseriate-triseriate pappus, *S. rigida*, scale bar = 0.43 mm; arrow indicates short outer pappus bristle. **11.** Uniseriate pappus, *S. altissima*, scale bar = 100 :m. **12.** Biseriate pappus with clearly overlapping inner and outer whorls of bristles, *S. odora*, scale bar = 0.43 mm. **13.** Biseriate pappus with shorter outer whorl (arrow) and longer inner whorl of bristles, *S. ulmifolia*, scale bar = 1 mm.

the whorl could easily be missed. Thus, other species of *Solidago* than those noted in Table 1 may also occasionally produce a secondary outer whorl. Within the North American Clade of the Astereae a short outer whorl of bristles is known in other species, but it is not always clear whether the short bristles are the primary or the secondary outer whorl, e.g., all species of *Doellingeria*, some species of *Eucephalus*, almost all species of *Erigeron*, most species of the goldenaster subtribe Chrysopsidinae (Semple 1996; Nesom 2000; Semple et al.

2002). In *Doellingeria*, the short outer bristles clearly make up the secondary outer whorl. In other genera, the outer short bristles may be the secondary outer whorl or the primary outer whorl. Additional research is needed on these genera.

Within each section and subsection variation was seen in each of the features examined, but patterns were still present. The strongest evidence for a biseriate nature of the pappus of *Solidago* was observed in members of *S.* sect. *Corymbosae* and in *S.* subsect. *Albigulae*. Members of subsect. *Junceae*, subsect. *Maritimae*, subsect. *Venosae*, subsect. *Triplinervae* nearly always were observed to have non-clavate to weakly clavate bristle tips. In three species in the latter subsection, no evidence of a biseriate pappus was detected: *S. altissima*, *S. canadensis*, and *S. gigantea*. These species had no observable alternation, no clavate qualities to the bristles and no overlapping at the bases.

SYSTEMATICS IMPLICATIONS

The determination that *Solidago* species generally have a biseriate pappus with a primary inner whorl of clavate bristles means the genus is not aberrant within the Solidagininae sensu Nesom (2000). Of the taxa examined, the most distinct pappus was that of *Gutierrezia sarothrae* which had erose scales rather than barbellate and sometimes clavate bristles. The results mean that pappus traits are not useful in separating *Oligoneuron* (= *S.* sect. *Corymbosae* here) from *Solidago*. If authors wish to do so, then the argument will need to rely on other differences. Within the genus *Solidago*, there is sufficient variation in pappus traits among members of subsections and series that pappus traits can not be used as diagnostic features of any infrageneric group with one exception. The very short pappus of *S. sphacelata* is unique and is diagnostic for ser. *Brachychaeta*, if the series is treated as monotypic, as done here. Nesom (1993) defined the series by its cordate to truncate basal leaves with winged petioles, strongly reduced cauline leaves, 0–3 ray florets, and markedly short pappus bristles; he included *S. sphacelata*, *S. auriculata* and *S. brachyphylla*. The bristles of the latter two species are about 2/3 the length of the corollas, while those of *S. sphacelata* are about 1/4 to 1/5 the length of the corollas.

The most obvious conclusion to be drawn is that older descriptions of pappus traits of members of the Astereae may not be accurate or sufficiently detailed. Future descriptions should be based on very careful observations at high dissecting scope magnifications or lower powered compound microscope magnifications. Use of the labels "primary inner and outer whorls" and "secondary whorl(s)" should facilitate and standardize additional research on pappus whorl variation in the Astereae.

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TYPIFICATION, TAXONOMY, AND A NEW SUBSPECIES OF *POLYGONUM SAWATCHENSE* (POLYGONACEAE) FROM NORTH AMERICA

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ABSTRACT

A new subspecies of *Polygonum sawatchense* Small is described and illustrated for the forthcoming treatments of the genus *Polygonum* (Polygonaceae) in Flora of North America and Jepson Manual, Flora of California: *Polygonum sawatchense* subsp. *oblivium*. *Polygonum sawatchense* is typified and its taxonomy and distribution in North America are discussed.

RESUMEN

Se describe y se ilustra una nueva subespecie de *Polygonum sawatchense* Small para los futuros tratamientos del género *Polygonum* (Polygonaceae) en la Flora de Norteamérica y el Jepson Manual, Flora de California: *Polygonum sawatchense* subsp *oblivium*. *Polygonum sawatchense* se ha tipificado y se discute su taxonomía y distribución en Norteamérica.

INTRODUCTION

Small (1893) described *Polygonum sawatchense* from some specimens collected by Katherine Brandegee in Sawatch Range, Colorado, U.S.A., and deposited in CAS. When Hickman (1984) proposed to treat this species at subspecific rank within *P. douglasii* Greene, he observed that these collections were presumably destroyed during the earthquake and fire of 1906. He did not propose a lectotype or neotype and instead adopted the epithet of the heterotypic *P. douglasii* var. *johnstonii* Munz, calling the subspecies *P. douglasii* subsp. *johnstonii* (Munz) J.C. Hickman (Hickman 1984). He thus cited the holotype of *P. douglasii* var. *johnstonii* when he made the new combination *P. douglasii* subsp. *johnstonii* (Hickman 1984). However, based on his annotations from various herbaria (e.g. CAS, DS, UC, RSA) later Hickman considered plants that agree morphologically with the type of *P. douglasii* subsp. *johnstonii* to be "intermediates between *P. douglasii* subsp. *douglasii* and subsp. *johnstonii*," whereas the type of *Polygonum douglasii* var. *johnstonii* published by Munz (1935) is actually within the range of variation of typical *P. sawatchense* Small. In fact, Hickman (1993) shifted the meaning of *P. douglasii* subsp. *johnstonii* to an undescribed taxon. During the preparation of the accounts of *Polygonum* s.str. for Flora of North

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America and the forthcoming revision of the Jepson Manual, Flora of California, it was concluded that *P. sawatchense* should be accepted at the specific rank. Plants that were referred to by Hickman (1993) as "*P. douglasii* subsp. *johnstonii*" are described here as a new subspecies, *P. sawatchense* subsp. *oblivium*.

MATERIAL AND METHODS

Descriptions and details of distribution of taxa are based on collections from: A, ALTA, CAS, DAO, DC, DS, GH, F, JEPS, LL, MT, MTMG, NY, OAC, POM, QFA, RSA, SASK, TEX, UBC, UC, USAS and US. Stem papillae are easily observed on young stems or toward apices of mature stems and branches, at magnifications higher than 50. Measurements of leaves, ocreae and petioles were made at the middle of the main stem. The state characters, "flowers closed" and "flowers wide-open" were observed on herbarium specimens. However, it should be noted that in fruit, flowers are always closed. Description of perianth refers to the fruiting perianth, which was measured from the joint with the pedicel. Pictures were taken with a Scanning Electron Microscope Hitachi S-570 at 15 KV. Samples were collected from herbarium specimens within the holdings of GH, NY and RSA; these collections were indicated with a "*" in the lists of representative specimens examined. Samples were coated with 30 nm gold using an Emitech K 550 Sputter Coater.

Typification of Polygonum sawatchense

A specimen collected by Brandegee from the Sawatch Range, Colorado is deposited in NY (00323810!), but it was not cited by Small (1893) in the protologue and, furthermore, it is damaged. A neotype is designated below from one of the specimens cited one year later by Small (1894) as "nearly like the original in every respect."

Taxonomy

Hickman (1984) proposed a new taxonomic concept for *P. douglasii* by including within it five other species: *P. sawatchense*, *P. spergulariaeforme* Meisn. ex Small, *P. majus* Meisn., *P. nuttallii* Small and *P. austiniae* Greene. Hickman (1984) justified these new combinations by the intermediate patterns of variation he observed between some of the taxa: "intermediates sometimes outnumber typical forms." For example, he reported such frequent intermediates between *P. douglasii* and *P. sawatchense* (Hickman 1984). However, even in this case Hickman admitted later that they "both may grow together without local intergradation" (Hickman 1993). We found that Hickman's intermediates (in herb.) are in most of the cases within the range of variation of each taxon, which has been poorly understood. *Polygonum sawatchense* is more variable than previously known and two subspecies, one of them formally undescribed, are recognized here. The two subspecies may partially intergrade in the areas of sympatry.

Polygonum sawatchense Small, Bull. Torrey Bot. Club 20:213, pl. 156. 1893. TYPE: U.S.A. Yellowstone Park, 1885, *T. Tweedy s.n.* (NEOTYPE, here designated: US!).

a. P. sawatchense subsp. sawatchense (Fig. 1a)

= *Polygonum douglasii* Greene var. *johnstonii* Munz, Man. So. Calif. Bot. 131:597. 1935; *P. douglasii* subsp. *johnstonii* (Munz) J.C. Hickman, Madroño 31:250. 1984.

Polygonum exile Eastw., Proc. Calif. Acad. Sci. Ser. 3, Bot. 2:286. 1902.

Polygonum triandrous Coolidge, Madroño 20:266. 1970.

Stems green to brownish, usually branched from base, 4–50 cm long, glabrous (Fig. 2a), with smooth faces and sometimes narrow winged angles. Leaves; ocreae glabrous; blades linear, narrow-oblong to oblanceolate, 15–45 × 2–8(–12) mm; margins usually revolute, glabrous (Fig. 2c); upper leaves abruptly reduced to scale-like bracts, or much longer than the flowers they subtend. Inflorescences axillary or of long, open spike-like racemes, 5–15 cm long; cymes (1–)2–4-flowered; bracts equalling, somewhat longer, or much longer than the flowers. Flowers closed; pedicels erect, 1–4 mm; perianth (2.5–)3–3.5 mm, the tube 25–40% of the perianth length, the tepals naviculate (Fig. 2e), greenish or reddish with white or pink borders, with midveins unbranched or with a few branches at base. Stamens 3–8; anthers pink to purple, 130–160 µm long. Achenes black, trigonous, 2.5–3 mm, ovate or elliptic, smooth.

Distribution and ecology.—CANADA: Alberta, Saskatchewan. U.S.A.: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, South Dakota, Utah, Washington, Wyoming. MEXICO: Baja California. It grows in dry meadows, pastures, sagebrush and forests on sandy, gravelly or rocky substrates. Flowering Jun–Aug.

It is important to emphasize that narrow-leaved plants regarded by Hickman as intermediates between *P. douglasii* subsp. *douglasii* and his "subsp. *johnstonii*," belong in fact to *P. sawatchense* subsp. *sawatchense*. Even with this narrow circumscription, *P. sawatchense* subsp. *sawatchense* is variable. "Typical" *P. sawatchense* plants described by Small from the Rocky Mountains, Colorado are relatively dwarf, 6–15 cm tall, dull green-brownish with persistent leaves that gradually transform into leaf-like bracts, 3–5 times longer than the flowers they subtend. Plants described as *P. douglasii* var. *johnstonii* by Munz from San Bernardino Mountains, California are taller, to 50 cm, with caducous green-glaucous, basal leaves, sharply differentiated from the bracts, which are equal to or up to 3 times as long as the flowers they subtend. However, we found a continuous transition between these two extremes, and a further subdivision of *P. sawatchense* subsp. *sawatchense* is apparently not possible. Collections of Patterson (1885) from the Rocky Mountains, near Golden, Colorado illustrate very well this transition. For example, *Patterson 131* (UC, NY) collected from elevations ranging from 3000 to 3300 m is "typical." Small himself observed that another collection (*Patterson 128*; NY, UC, US) from an elevation of 1800 m

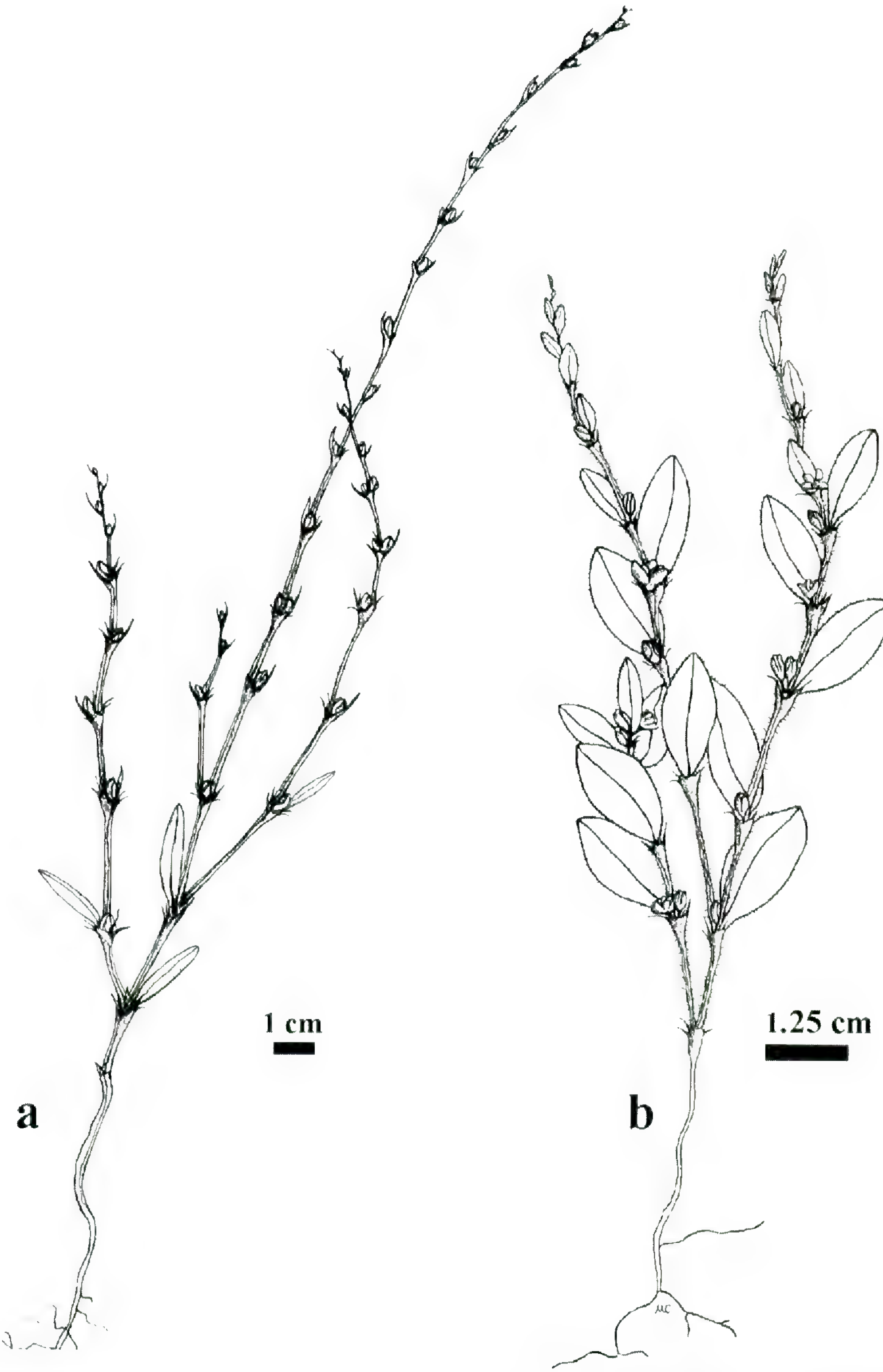


FIG. 1. *Polygonum sawatchense*, general habit; **a.** *P. sawatchense* subsp. *sawatchense*, based on *P.A. Munz & M. Johnston 8506* (RSA), **b.** *P. sawatchense* subsp. *oblivium*, based on *F.W. Oettinger 260* (RSA).

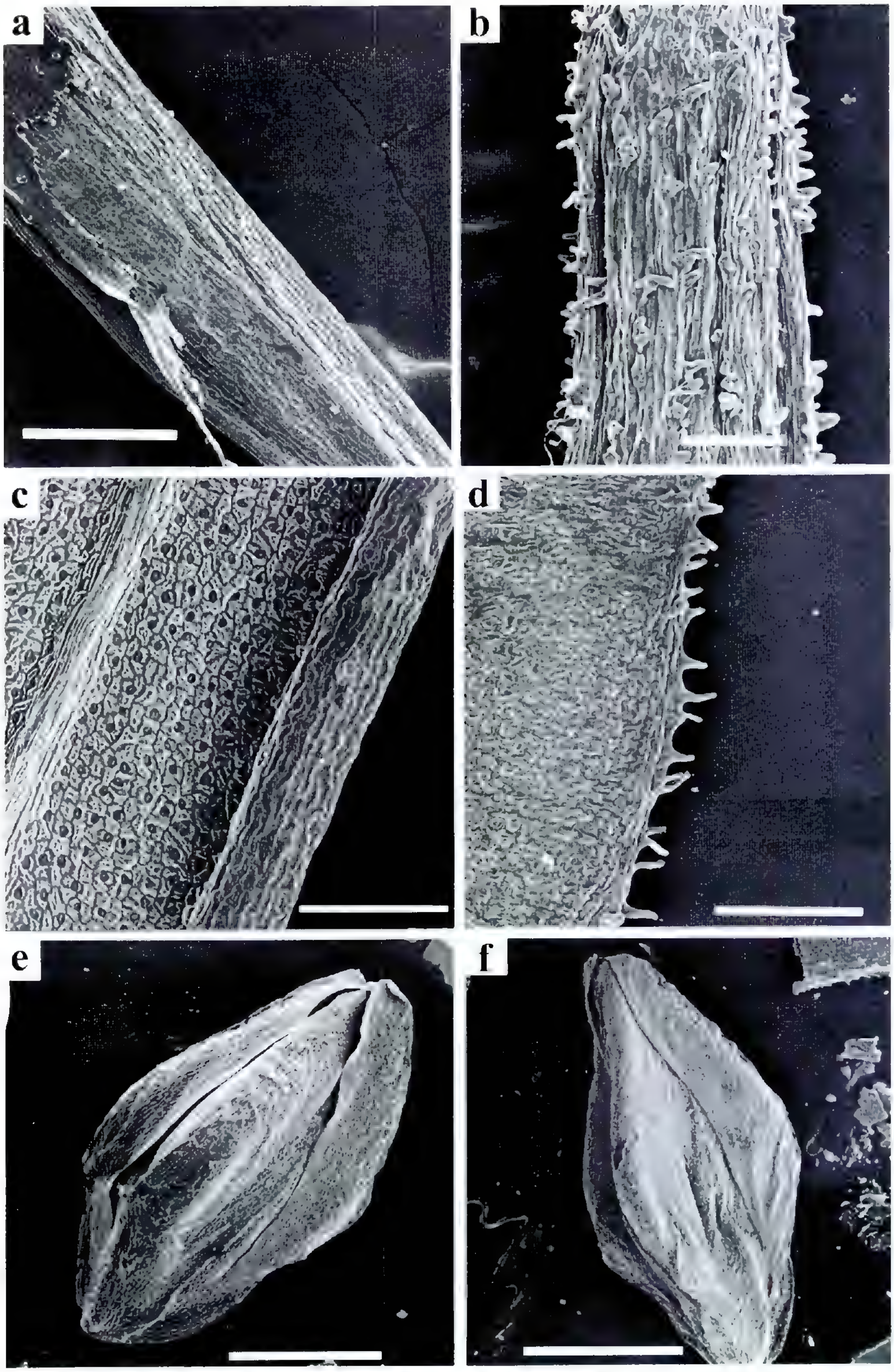


FIG. 2. **a–b.** Morphology of stem: **a.** *Polygonum sawatchense* subsp. *sawatchense* (scale bar = 0.5 mm), **b.** *P. sawatchense* subsp. *oblivium* (scale bar = 0.3 mm), **c–d.** Margin of leaves: **c.** *P. sawatchense* subsp. *sawatchense*, **d.** *P. sawatchense* subsp. *oblivium* (scale bar = 0.3 mm), **e–f.** Fruiting perianth: **e.** *P. sawatchense* subsp. *sawatchense*, **f.** *P. sawatchense* subsp. *oblivium* (scale bar = 1 mm).

"is more elongated and rather straggling" and that "this difference is most likely due to their unlike habitats and altitudes" (Small 1894).

Representative specimens examined. **CANADA. ALBERTA. Cypress Hills Region:** Chappice Lake, 23 Jun 1990, *J.H. Hudson 4921* (SASK). **SASKATCHEWAN. Moose Jaw Region:** Grasslands Park, 9 mi SE of Val Marie, 17 Jul 1989, *E.R. Hooper 11110* (USAS). **Swift Current Region**: Altawan, 49E14'30"N 109E55'W, 8 Jul 1999, *J.H. Hudson 5407* (SASK). **U.S.A. ARIZONA. Apache Co.:** 3.5 mi E of McNary, roadside, ponderosa pine forest, 13 Aug 1974, *D.J. Pinkava 12343 et al.* (US, NY). **Coconino Co.:** Buch Springs Ranger Station, 7500 ft, Sep. 1936, *R.E. Collom 599* (US); Flagstaff, 2 Aug 1884, *M.E. Jones 3957* (RSA*). **Cochise Co.:** Chiricahua Mountains, Coronado National Forest, S base of Barfoot Peak, 8200 ft, 4 Sep 1983, *D. Ward & D. Peterson s.n.* (RSA*); road to Rustler Park, 7600 ft, 14 Oct 1943, *T.H. Kearney & R.H. Peebles 15104* (UC). **Gila Co.:** Workman Creek Canyon, near end of car road, Sierra Ancha Mountains, 5500 ft, 27 Aug 1946, *F.W. Gould 3734* (GH). **Greenlee Co.:** Apache National Forest, 13 mi S of Strayhorse Campground, just N of Blue Lookout, ponderosa pine, 24 Jul 1973, *D.J. Pinkava 11280A et al.* (US, NY). **CALIFORNIA. Fresno Co.:** Hutchinson Area, Piute Canyon, 10 mi E Florence, 12100–12500 ft, 18 Aug 1955, *C.H. Quibell 5847* (RSA). **Inyo Co.:** Head of Wyman Canyon, White Mountains, 10000 ft, 19 Jul 1955, *P.A. Munz 21043* (RSA). **Lassen Co.:** Harvey Valley, 9 Jul 1934, *J.T. Howell 12528* (GH, RSA*). **Modoc Co.:** NW side of Bidwell Mountain, 2.8 mi N of 8 mi creek on the road from Lake Annie, 30 Jun 1984, *A. Tiehm 8841* (RSA); Duncan Horse Camp, 1 Jul 1934, *J.T. Howell 12317* (GH, NY). **Mono Co.:** Sweetwater Mountains, site of Star City, 8500 ft, 12 Jul 1975, *M. DeDecker 3958* (RSA); Sierra Nevada, Little Lake, 3300 m, 20 Jul 1969, *M. DeDecker 2183* (RSA). **Nevada Co.:** Dog Valley, 5500 ft, 30 Jun 1913, *A.A. Heller 10897* (JEPS, NY, US). **Riverside Co.:** Santa Rosa Peak, Virgin Springs, 7500 ft, 14 Aug 1938, *P.A. Munz 15359* (RSA*) **San Bernardino Co.:** San Bernardino Mountains, bellow Dollar Lake, 8700 ft, 22 Aug 1922, *P.A. Munz 6190* (RSA*, UC). **Tulare Co.:** Head of Monache Meadows on S Fork of Kern River, 8050 ft, 13 Jul 1950, *P.A. Munz 14994* (RSA); Mineral King, 8000 ft, 19 Jul 1951, *L.S. Rose s.n.* (RSA, UC). **Ventura Co.:** Pinos Mountain, 8400 ft, 30 Jul 1922, *F.W. Peirson 3223* (RSA). **COLORADO. Conejos Co.:** 7 mi N of Conejos Campground, NW of Antonito, 19 Jul 1952, *W.A. Weber 7862* (RSA*). **Grant Co.:** Rocky Mountain National Park, 2.25 mi WSW of Mount Bryant, granite soil origin, 8500 ft, 4 Aug 1936, *Sawyer & Rutter 118b* (UC). **Gunnison Co.:** 3 mi N of Almont, on road to Crested Butte, 8500 ft, 2 Aug 1955, *W.A. Weber 9376* (GH, RSA, UC). **Larimer Co.:** Moraine Park, 11 Aug 1925, *G.E. Osterhout 6464* (RSA*). **Montezuma Co.:** Mesa Verde National Park, near Cedar Tree Tower ruins, ca. 7100 ft, 26 Jul 1949, *H. Bailey & V. Bailey 3106* (UC). **Rio Grande Co.:** West Fork San Francisco Creek, Del Norte Ranger District, Rio Grande National Forest, 7 Aug 1984, *B.H.M. Mooers 437* (NY). **IDAHO. Blaine Co.:** Ketchum, 5877 ft, 20 Jul 1911, *A. Nelson & J.F. Macbride 1246* (RSA). **NEVADA. Clark Co.:** Charleston Mountains, Charleston Park, 2270 m, 29 Jul 1938, *I.W. Clokey 7901* (GH, NY, RSA*, UC); Pipeline Canyon to Rainbow Falls, E of Cathedral Rock, Charleston Mountains, 8200 ft, 30 Jul 1938, *P. Train 243* (GH, NY, UC). **Elko Co.:** Lamoille Canyon, Ruby Mountains, 20 Jul 1938, *F.W. Pennell & R.L. Shaffer 23307* (GH). **Humboldt Co.:** Pine Forest Range, 11 mi N of Leonard Creek Ranch, 6400 ft, 27 Jun 1964, *N.H. Holmgren & J.L. Reveal 1120* (GH, NY, RSA*, UC). **Mineral Co.:** Cottonwood Creek Canyon, 4 mi below Laphan Meadows Mountain, Grant Rd., 7800 ft, 22 Jun 1940, *P. Train 4109* (NY, UC). **Nye Co.:** Pine Creek Canyon, frequent, gravelly sagebrush slopes, 20 Jul 1940, *B. Maguire & A.H. Holmgren 25861* (GH, NY, UC, US). **Washoe Co.:** 20 mi NE of Gerlach, 5500 ft, 20 Jun 1942, *C. McMillan & K.H. McKnight 147* (NY). **NEW MEXICO. Catron Co.:** between Luna and the Arizona border on Hwy. 180, 14 Aug 1973, *R. Spellenberg & M. Spellenberg s.n.* (NY). **Chaves Co.:** Roswell, 21 May 1931, *A. Nelson 11587* (UC). **Colfax Co.:** vicinity of Ute Park, 2200–2900 m, 26 Aug 1916, *P.C. Standley 13847* (US). **Grant Co.:** Piños Altos Mountains, 24 Sep 1931, *M.E. Jones 28608* (RSA). **Lincoln Co.:** White Mountains, 7400 ft, 25 Aug 1907, *E.O. Wooton & P.C. Standley s.n.* (US). **McKinley Co.:** Zuni Mountains, 8 mi E of Hwy. 32 on road to McGaffey inside Cibola National Forest, 16 Aug 1973, *R. Spellenberg & M. Spellenberg s.n.* (NY). **San Miquel Co.:** T. M. O'Connor Ranch, South Rim Pasture, 6900 ft, 1.5 mi E of Las Vegas, 28 Jul 1984, *S.A. Hill 14631* (NY, RSA*). **Taos Co.:** Apache Springs, Apache Peak, Carson

Forest, 3000 m, 22 Aug 1923, *W.W. Eggleston 19162* (US). **Valencia Co.:** Mount Taylor, San Mateo Mountains, College experimental area, 20 mi E of Grants, 8300 ft, 4 Sep 1935, *K.F. Parker 2333* (RSA*). **UTAH. Grand Co.:** Uintah and Ouray Indian Reservation, 59 mi S of Ouray, along Weaver Reservoir Rd., 8500 ft, 30 Jul 1965, *N.H. Holmgren et al. 2309* (GH, NY). **Juab Co.:** Ridge above junction of Nebo Loop Rd. and Salt Creek Rd., 6400 ft, 1 Jul 1983, *K. Thorne & J. Thorne 2523* (NY). **Salt Lake Co.:** Big Cottonwood Canyon, 8000 ft, 17 Aug 1941, *J.F. Brenckle et al. s.n.* (GH, NY, US). **San Juan Co.:** S side of Abajo Mountains, 2000–2500 m, 28–29 Jul 1911, *P.A. Rydberg & A.O. Garrett 9270* (NY, US). **Washington Co.:** Pine Valley Mountains, 6760 ft, 2 Aug 1967, *J.L. Gentry Jr. 2256* (NY); Zion National Park, East Rim trail, Echo Canyon, 11 Jul 1949, *H. Bailey & V. Bailey 3537* (UC). **WYOMING. Crook Co.:** Bear Lodge Range, Reuter Canyon, 5 mi N of Sundance, 5800 ft, 12 Jul 1960, *C.L. Porter & M.W. Porter 8374* (RSA*, UC). **Fremont Co.:** Togwotee Pass, 26 Jul 1939, *J.F. Brenckle 39-139 & S.D. Mellete* (RSA, NY, UC, US). **Natrona Co.:** Southern Powder River Basin, 10 mi SW of Waltman along Powder River, 6400 ft, 6 Jul 1993, *R.L. Hartman 40486* (UC). **Weston Co.:** Black Hills, Elk Mountain Area, Clifton Canyon, above Last Canyon, 4700 ft, 8 Aug 1984, *H. Marriott 8809* (NY). **MEXICO. BAJA CALIFORNIA**: Sierra, San Pedro Martir, Dead Horse Meadow, SW end of Venado Blanco, 17 Jul 1988, *S. Boyd 2628 et al.* (RSA*); Vallecitos Meadow, 2400 m, 26 Aug 1973, *R. Moran 21127* (RSA).

b. Polygonum sawatchense subsp. **oblivium**, Costea & Tardif, subsp. nov. **(Fig. 1b).** TYPE: U.S.A. CALIFORNIA. Siskiyou Co.: Salmon Mountains, High Lake Basins in the vicinity of English Peak, Marble Mountain Wilderness Area, gully near meadow SE of Tom Taylor Cabin, elevation 6700 ft, 13 Aug 1967, *F.W. Oettinger 260* (HOLOTYPE: RSA).

Polygonum douglasii subsp. *johnstonii* auct

Polygono sawatchensi subsp. *sawatchense* affinis sed caulis scabri-papillosis et foliis oblongi-ellipticis vel ellipticis, marginibus papillosi-denticulatis differt.

Stems green, simple or with a few branches from base, 5–15(–25) cm long, papillose scaberulous on and between ribs; papillae white, patent, dense, conic-cylindrical, 90–150 µm long (Fig. 2b). Leaves; ocreae 4–10 mm, scaberulous, with the free part lacerate or disintegrating into a few fibers; blade elliptic to oblong-elliptic, gradually decreasing in size upwards and persistent at flowering-fruiting stage, 8–20(–25) × 5–10 mm, acute at both ends; margins plane, papillose-denticulate; papillae similar to those present on the stems (Fig. 2d). Inflorescences mostly axillary or if a terminal spiciform raceme present, then less than 5 cm long; cymes-1–3(–4)-flowered. At least some flowers wide-open; pedicels 1–3 mm. Perianth 3–4 mm, the tube 20–30% of the perianth length, tepals oblong-elliptic, cucullate, naviculate and overlapping (Fig. 2f), greenish-white or greenish-yellow (sometimes flushed with purple) with white borders the mid-veins greenish or brown, usually branched at base. Stamens 8; anthers pink to purple, rarely whitish, 130–200 µm. Achenes black, trigonous, 2.6–3.3 mm, elliptic to elliptic-ovate, smooth.

Distribution and ecology.—CANADA: British Columbia. U.S.A.: California, Idaho, Nevada, Oregon and Washington. It has the same ecology as subsp. *sawatchense*, but unlike the latter may also grow in shaded or moist places. Flowering Jun–Aug.

This taxon has been usually referred to as *P. douglasii* subsp. *johnstonii* (e.g.

by Hickman 1993). The protologue of *P. douglasii* var. *johnstonii* indicates only that it has erect pedicels, 1 mm long (Munz 1935). Hickman (1984) studied the holotype of *P. douglasii* var. *johnstonii* from RSA (*Munz & Johnston 8506*) when he included *P. sawatchense* within his new subspecies of *P. douglasii*. He noted: "the type shows several features of subsp. *douglasii* but it is closer to the extreme of subsp. *johnstonii* so the latter epithet can be retained at subspecific rank" (Hickman 1984). However, only almost 10 years later, in the Jepson Manual (1993) did it become apparent what Hickman understood by "subsp. *johnstonii*." He described this taxon as having "persistent leaves, all elliptic" (Hickman 1993). This intrigued us because Munz's holotype has caducous, narrow, oblong-lanceolate leaves. Even Munz specified later (Munz & Keck 1968) that, except for the erect and short pedicels, *P. douglasii* var. *johnstonii* is like *P. douglasii* (var. *douglasii*), namely with narrow, oblong-lanceolate leaves. Apparently, Hickman changed the original meaning of this name, from the plants of Munz, which are within the range of variation of typical *P. sawatchense*, to a taxon that has not been formally described. These plants are called here *P. sawatchense* subsp. *oblivium*. This confusion induced Hickman to consider plants of *P. douglasii* with broad leaves (var. *latifolium* Greene), as well as typical plants of *P. sawatchense*, to be intermediates "between subsp. *douglasii* and subsp. *johnstonii*" (Hickman, in herb.).

The stems of *Polygonum sawatchense* subsp. *oblivium* are scaberulous-papillose (Fig. 1b, 2b), the leaves are oblong-elliptic to elliptic (Fig. 1b), papillose-denticulate on the margins (Fig. 2 d) and the flowers, at least some of them, are open. *Polygonum sawatchense* subsp. *sawatchense* is entirely glabrous, the leaves are linear to oblanceolate (Fig. 1a, Fig. 2a, c), and flowers are normally closed. The tepal surface pattern of the two taxa is also different (Costea & Tardif, unpublished). Both subspecies occur in California, Idaho, Nevada and Washington. However, *P. sawatchense* subsp. *sawatchense* is more widely distributed, extending from Mexico, Arizona and New Mexico to Utah, Wyoming, Montana, South Dakota, North Dakota and Canada - Alberta and Saskatchewan. Although the two taxa are usually distinct, intermediate variation patterns may occur in the areas of sympatry, and this is why we treated them as subspecies. For example, glabrous plants with more or less broad and gradually decreasing leaves, as well as papillose-scaberulous plants with relatively narrow leaves, may be occasionally encountered.

Munz, who described *P. douglasii* var. *johnstonii* (1935), observed that this was different from *P. sawatchense* subsp. *oblivium*, but he usually identified the latter plants as *P. austiniae* (e.g. *Munz 18361*, RSA). *Polygonum sawatchense* subsp. *oblivium* differs from *P. austiniae* through its erect pedicels and much larger achenes. *Polygonum sawatchense* subsp. *oblivium* has also been frequently confused with *P. minimum*. They differ in respect to the morphology of leaves and ocreae, stems, size of fruiting perianth and achenes, as well as the pattern of

epicuticular wax sculpture of tepals (Costea & Tardif, unpublished). In particular, *P. minimum* has leaves that are hardly reduced distally, funnelform ocreae, 1–4 mm long, papillae on stems and ocreae are conical, short, with a swollen base, and flowers and achenes are usually much smaller.

Representative specimens examined. **CANADA. BRITISH COLUMBIA:** Road up to Windy Joe, Manning Park, roadside, 4800 ft, 4 Aug 1957, *K. Beamish 7856* (GH*, UBC). **U.S.A. CALIFORNIA. El Dorado Co.:** meadow near Fallen Leaf Lake, 21 Jun 1920, *A.M. Ottley 822* (NY). **Humboldt Co.:** Grouse Mountain, gravelly moist flat, 5000 ft, 30 Aug 1933, *J.P. Tracy 13023* (UC); 14 Jul 1935, *J.P. Tracy 14042* (UC). **Modoc Co.:** common in dry forest openings; with *Abies concolor*; Northern Juniper Woodland, 7 mi North of Fort Bidwell, 6150 ft, 7 Jul 1955, *R.J. Weatherby 1608* (RSA). **Nevada Co.:** Castle Peak, 31 Jul 1903, *A.A. Heller s.n.* (F, GH*, NY, RSA). **Plumas Co.:** Scattered annual growing in volcanic gravel with *Purshia tridentata*; Red fir forest, Bear Ridge near Taylor Lake; 7200 ft, 2 Jul 1955, *R.J. Weatherby 1570* (RSA); ca. 0.5 mi below Red Rock lookout, ca 8 mi S of Susanville, bare reddish gravel and outcrop between road and cliff, ca. 7000 ft, 3 Jul 1989, *B. Ertter 8642* (UC). **Siskiyou Co.:** rocky summit, ridge road to Deadwood Lookout, mountains west of Yreka, 25 Jun 1952, *M. Ownbey & S.J. Preece, Jr. 3345* (NY*); Salmon Mountains, open site northeast side of creek bed, Tom Taylor cabin, 6700 ft, 11 Aug 1968, *F.W. Oettinger 471* (RSA); Paynes Springs, 2 mi SE from Medicine Lake, sandy shallow-soil basins on recent lava flows situated in *Abies magnifica* forest, 6550 ft, 26 Jun 1987, *D.W. Taylor 9075* (UC); Grass Lake, 18 Jul 1948, *H.L. Mason 13623* (RSA*, UC). **Truckee Co.:** 1/2 mi W of Lake Van Norden, 7000 ft, 22 Jun 1934, *N. French 478* (RSA). **IDAHO. Elmore Co.:** W side Lava Mountain at headwaters of Russell Gulch, Boise National Forest N of Smith Prairie, sandy soil on granite, dry shade of forest, 7500 ft; 15 Jul 1981, *B. Ertter & J.W. Grimes 4531* (NY, RSA*). **Valley Co.:** Dry slope 3 mi N and W of Payette Lake, 6000 ft, 25 Jun 1946, *C.L. Hitchcock & C.V. Muhlick 13971* (NY). **NEVADA. Elko Co.:** among rock outcrops on hillsides above Maggie Summit, Bull Run mountains; with *Prunus* and *Amelanchier*; 6700 ft; 20 Jun 1980, *J.W. Grimes et al. 1646* (NY*). **Humboldt Co.:** Sonoma Range, Water Canyon, sandy steep E facing slope with sagebrush; frequent, 6800 ft, 10 Jul 1964, *N.H. Holmgren & J.L. Reveal 1374* (NY*); Jackson Range, ca. 50 mi WNW of Winnemucca; halfway up road to mines at head of Jackson Creek, dry NW facing slope between streamlet and rimrock outcrops; 2100 m, 14 Jun 1987, *B. Ertter 7146 et al.* (RSA, UC). **OREGON**: Woods, Achoco Forest, 22 Jun 1932, *M.E. Peck 17068* (NY*). **Grant Co.:** Malheur National Forest; Strawberry Mountain Wilderness, on Strawberry Mountain, woods of *Pseudotsuga*, *Abies grandis*, *Larix* and *Pinus*, 6500 ft, locally abundant on dry slopes, 12 July 1973, *M.F. Denton 3188* (US); Aldrich Mountains, slopes between Fields Creek summit and Fields Peak, 5500 ft, 20 Jul 1962, *A.R. Kruckeberg 5465* (UC). **Josephine Co.:** common in a neglected field, summit of the Siskiyou Mountains, yellow pine belt, 4500 ft, 21 Jun 1922, *A.A. Heller s.n.* (F, NY*); Oregon Caves, 6000 ft, 24 Jun 1934, *H.E. Parks 4892* (UC). **Lake Co.:** dry flat under aspens and pines near meadow; Willow Creek Forestry Camp, Warner Mountains; 5800 ft, 24 Jun 1973, *P.A. Munz 18361* (RSA*). **Maihew Co.:** Juniper Springs, 1350 m, 15 Jun 1896, *J.B. Leiberg 2275* (UC). **WASHINGTON. Asotin Co.:** open slopes along ridge leading N of Big Butte on the breaks of the Grand Ronde River, 5000 ft, 3 Jun 1939, *F.G. Meyer 1622* (GH*). **Okanogan Co.:** lower wooded slopes of Billy Goat Mountain, 4000 ft, 10 Jul 1934, *J.W. Thompson 10891* (NY). **Wallowa Co.:** Ice Lake Trail, Wallowa Mountains, 26 Jun 1936, *A. Eastwood & J.T. Howell* (NY).

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erences from California, and Laura Echarte checked our Spanish translation of the abstract.

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TYPIFICATION AND NOMENCLATURAL HISTORY OF *TRACHELOSPERMUM DIFFORME* (APOCYNACEAE)

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ABSTRACT

This study documents type specimens for names associated with the twining vine *Trachelospermum difforme*. Although not cited in the literature, a holotype of *Echites difformis* Walter was discovered in the Thomas Walter herbarium of the Natural History Museum, London. Types and nomenclatural history are discussed for other synonyms and combinations.

RESUMEN

Se documentan tipos para nombres asociados con la enredadera *Trachelospermum difforme*. Aunque no citado en la literatura, fue descubierto un holotipo en el herbario de Thomas Walter en el Museo de Historia Natural, Londres. Se dan tipos e historia de nombres para los sinónimos y combinaciones.

The twining vine *Trachelospermum difforme* (Walter) A. Gray (Apocynaceae) is native to the eastern United States and was first described as *Echites difformis* Walter in 1788. However, Walter did not indicate specimens he had studied. His herbarium is housed at the Natural History Museum (BM), London, and photographs thereof may be found in the collections of the Gray Herbarium (GH) at Harvard University. Walter's herbarium contains 122 sheets, a great many of which are plants of his *Flora Caroliniana* (Walter 1788; Stafleu & Cowan 1988). Although numerous authors proposed new combinations based on Walter's *Echites difformis*, none cited an appropriate type specimen. As typification is an ICBN requisite (Greuter et al. 2000), this study seeks to document types for names associated with the species *Trachelospermum difforme*.

In his treatment of *Forsteronia*, Alphonse de Candolle (1844) cites two specimens for the entity *Trachelospermum difforme*: "in Virginia infer. (Pursh) Carolina! et Mississippi (Torr.! in h. Boiss.)." However, John Torrey was not born until 1796 and Frederick Pursh visited North America for the first time in 1799—well after Walter's Flora had been published (Stafleu & Cowan 1983, 1986). For his new combination based on *Echites difformis*, John Miers (1878) cited a Florida specimen ("v.s. in herb. Mus. Brit. Florida (Chapman)"). However, this specimen also cannot be considered as Walter's type as it was collected by Alvan Chapman (1809–1899) in 1845, many years after Walter's death in 1789. Lacking further citation in the literature of potential types seen by Walter, a search of the Walter herbarium at BM was undertaken by the author. Fortunately, the

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search revealed a specimen of the taxon (*Walter 215*)—which should thus be considered the holotype of *Echites differmis* Walter.

In 1803, André Michaux proposed the name *Echites puberula* in his *Flora Boreali Americana* for the taxon in question. Three specimens that can be considered types for this name reside at the Muséum National d'Histoire Naturelle (P) in Paris. One specimen exhibits flowers in bud and a handwritten note "*Foresteronia differmis* A. DC." Another specimen exhibits fully opened flowers (but no labels) and the last exhibits fruiting material. From Michaux's protologue it is clear that both flowering and fruiting materials were available to him at the time of description.

In 1817, Poiret published the name *Tabernaemontana populifolia* and indicated seeing a specimen in "herb. Desfont." Poiret's name has long been cited in synonymy with *Trachelospermum difforme*. However, Poiret's type at FI-W does not belong to *Trachelospermum* (stems stout; lamina decurrent onto petioles). Recent annotations suggest it belongs to *Logania populifolia* (Lam.) Leeuwenberg (see also Leeuwenberg 1991). A small sachet (5 cm × 5 cm) of likely the same material resides at P, but bears no indication of locality (Aymonin, per. comm.). As the type belongs to another taxon, *Tabernaemontana populifolia* Poir. is here excluded from synonymy with *Trachelospermum difforme* (Walt.) A. Gray.

Miers, in proposing a new combination based on Poiret's name (i.e., *Thyrsanthus populifolius* (Poir.) Miers., Apocyn. S. Amer. 99. 1878.), indicated seeing a specimen collected by "Marshal [sic]" from Georgia in "herb. Mus. Brit." This specimen is indeed *Trachelospermum difforme* (BM!) and not *Logania populifolia*, however Miers' combination cannot be applied to the former species as ICBN Art. 7.4 holds that new combinations, in all circumstances, are typified by the type of the basionym (Greuter et al. 2000).

In 1836, Rafinesque proposed the name *Echites salicifolia*. However, this name is a *nomen illegitum* since *Echites salicifolia* Willd. ex Roem. & Schult. (=*Allamanda cathartica* L., Apocynaceae) was validly published in 1819 (Systema Vegetabilium 4:796). No type specimen could be located for Rafinesque's name. Unfortunately, as Stuckey (1971) notes, Rafinesque's herbarium was partially destroyed by rats after his death and virtually all the remaining material was discarded by Elias Durand. *Echites salicifolia* Raf. is not listed among Rafinesque's North American vascular plants at PH (Stuckey 1971), nor are potential type specimens found in the collections of GH and NY. Inquires with P and DWC also provided no material.

TAXONOMIC SUMMARY

Trachelospermum difforme (Walter) A. Gray, Syn. Fl. N. Amer. 2:85. 1878. *Echites differmis* Walter, Fl. Carol. 98. 1788. *Forsteronia differmis* (Walter) A.DC., Prodr. 8:437. 1844. *Secondatia differmis* (Walter) Benth. & Hook.f., Gen. Pl. 2:710, 723. 1876.

nom. invalid. *Thyrsanthus difformis* (Walter) Miers, Apocyn. S. Amer. 99:1878. *Thyrsanthella difformis* (Walter) Pichon, Bull. Mus. Natl. Hist. Nat. ser. 2, 20:192. 1948. TYPE: *Walter 215* (HT:BM!).

Echites puberula Michx., Fl. Bor. Amer. 1:120. 1803. TYPE: *Michaux s.n.* [protologue: "*in sylvis Carolinae inferioris*"] (ST: P; IDC Fiche! [three specimens: one with flowers in bud, one with flowers, and one with fruits]).

Echites salicifolia Raf., New Fl. N. Amer. 4:59. 1838 ('1836'), nom. illeg.; non Willd. ex Roem. & Schult. 1819. TYPE: unknown.

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NEW NAMES AND NEW COMBINATIONS IN THE FLORA OF HISPANIOLA

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In revising the published Flora of Hispaniola (1981, 1989, 1994, 2000), I have found a need to make revisions in nomenclature of some taxa. Some names were antedated by previous publications, and this came to my attention when I was verifying publication dates through the W3TROPICOS (2003) database on the web page of the Missouri Botanical Garden.

The following changes are made to correct inadvertent errors I have made for lack of complete bibliographies in the past. I am very grateful to W3TROPICOS for enabling me to catch these errors. I also want to thank the Botanical Research Institute of Texas, for the use of its library and the facilities given to me for my research. The National Botanic Garden in Santo Domingo has a very good plant collecting program underway, along with a number of detailed florulas.

ASCLEPIADACEAE

Matelea monticola Alain, nom. nov. *Matelea sylvicola* Alain, Phytologia 22:168. 1971, non *Matelea sylvicola* L.O. Williams, Fieldiana, Bot. 32:57. 1968.

CELASTRACEAE

Maytenus urbanii Alain, nom. nov. *Maytenus impressa* Urb. & Ekm., Ark. Bot. 22 A(8):67. 1928, non *Maytenus impressa* Reissek, Fl. Bras. 11(1):29. 1861.

MELASTOMATACEAE

Leandra urbaniana (Alain) Alain, comb. nov. BASIONYM: *Ossaea urbaniana* Alain, Brittonia 20:158. 1968. *Ossaea polychaeta* Urb. & Ekm., Ark. Bot. 23A(11):27. 1931.

non *Ossaea polychaete* Urban & Ekm., Ark. Bot. 22A(17):60. 1929. *Leandra polychaeta* (Urb. & Ekm.) Alain, Sida 18:1026. 1999, non *Leandra polychaeta* Cogn. in A. DC. & C. DC., Monogr. Phan. 7:1186. 1891.

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TROPICOS. 2003. Click on w3TROPICOS (www.mobot.org) to access the taxonomic database.

GLANDULARIA VERECUNDA (VERBENACEAE): SPECIES OR FRUIT-FORM?

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In the most recent issue of Sida, Henrickson (2003) treated *Glandularia verecunda* Umber as a distinct species, this in sharp contrast to the present author's treatment of the taxon as but a fruit-form of *G. quadrangulata* (Heller) Umber (Turner 1999). My reason for this disposition followed several years of field work in which I could find no differences between the two hypothetical species except that of a terminal appendage on the apex of *G. verecunda*, this nicely illustrated by Henrickson's Fig. 1.

Glandularia verecunda was first proposed by Umber (1979), the species name said to be derived from the Latin word *verecundus* or "bashful," presumably in reference to the taxon's proclivity to go unnoticed, both in the herbarium and in the field. Indeed, Umber's description of the taxon nearly matches that of *G. quadrangulata*, except for the terminal appendage on the fruit. Turner (1999) clearly noted that Umber himself remarked that *G. verecunda* is "indistinguishable from *G. guadrangulata* except for the seeds," meaning the presence of an appendage on the nutlets.

Glandularia verecunda and G. quadrangulata are partially if not largely sympatric over most of their distributions (not "largely allopatric" as stated by Henrickson, his use of the term sympatric apparently restricted to *intrapopulational* occurrences of the two taxa).

After a discussion "Of the three nomenclatural possibilities: (1) being inconsequential forms of each other; (2) being geographical subunits of a species, i.e. subspecies or varieties of one species; or (3) being separate species that merely co-occur in some areas," Henrickson surmises that the two taxa are distinct species "that are very similar vegetatively but can co-occur without interbreeding as no intermediates have been found." Immediately thereafter, he concluded his discussion with a terse paragraph, as follows:

> "If there was evidence of interbreeding, they [sic] the two taxa could be recognized at the infraspecific level. But this does not exist. Therefore the two taxa will here be recognized as distinct species."

Henrickson comments further that "No plants have ever been discovered in nature with nutlets intermediate in structure between those of *G. quadrangulata and G. verecunda* ... Furthermore, no artificial hybridization has been done to

determine the condition that would be expressed in a hybrid." Needless to say, this same comment might be applied to most any albino form occurring in natural populations; nor does one spend much effort seeking out an intermediate plant to prove the point!

Fruit forms (or fruit polymorphism) in natural populations are relatively rare, but are relatively common in some groups such as, for example, the genus *Valerianella* (Valerianaceae). The interested reader is referred to the work of Ware (1983), who detailed numerous fruit forms in *Valerianella*, several of which had long been recognized as species. For those interested in the genetics of such fruit types, the work of Xena de Enrech and Mathez (1998) might be consulted.

Fruit forms also occur in other Texas plants, for example in the genus *Thelesperma* (Asteraceae). The species *T. curvicarpum* Metchert, first described in 1963 from Burnett and Coleman counties, Texas, was subsequently shown to be but a fruit-form (Greer 1997). And it is likely that my description of *Cynoglossum hintoniorum* Turner (Boraginaceae) amounts to no more than a fruit-form of the widely distributed *C. amabile* Stapf & Drumm. (Turner 1995).

Finally, it should be reemphasized that I have called to the fore in the above-mentioned publication several populations of *G. quadrangularis* in which appendaged and nonappendaged fruits occur intermixed. The two forms can be separated only by the appendages on their nutlets, but I have no trepidation in recognizing this fruit-form as a named taxon, as follows:

Glandularia quadrangulata forma **albida** (Moldenke) B.L. Turner, comb. nov.
BASIONYM: *Verbena pumila* forma *albida* Moldenke, Phytologia 9:188. 1963.

= *Glandularia verecunda* Umber

Umber (1979 treated the forma as a synonym of his concept of *G. verecunda*. It is unfortunate to have to take up the name "albida" for this fruit-form, but the Code of Botanical Nomenclature mandates use of the earliest name in rank as having priority.

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XENA DE ENREICH, N. and J. MATHEZ. 1998. Genetic control of fruit polymorphism in the genus *Fedia* (Valerianaceae) in the light of dimorphic and trimorphic populations of *F. pallescens*. Pl. Syst. Evol. 210:199–210.

NEW COMBINATION IN ASTEREAE (ASTERACEAE)

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The following combination is necessary to complete a set of subtribal names for the developing treatment of Asteraceae tribe Astereae (Asteraceae) by Guy Nesom and Harold Robinson for "The Families and Genera of Vascular Plants" (Vols. I–V, 1990–2003: K. Kubitzki, General Editor; J.W. Kadereit and C. Jeffrey, Volume Editors for Asterales).

Asteraceae tribe **Astereae** subtribe **Bellidinae** (Cass. ex D. Don) G. Nesom & H. Robinson, comb. et stat. nov. BASIONYM: Asteraceae tribe Bellideae Cass. ex D. Don in R. Sweet, Brit. Fl. Gard. 1: ad t. 38. 1830. TYPE: *Bellis* L.

REFERENCE

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Horticulture/Gardening

ROBERT NOLD. 2003. **Columbines: *Aquilegia, Paraquilegia,* and *Semiaquilegia.*** (ISBN 0-88192-588-8, hbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $24.95, 193 pp., 45 color photos, 8 watercolors, 4 line drawings, 6 × 9".

Contents.—Preface, Acknowledgments, Cultivation, Pests and Diseases, Propagation, Morphology and Distribution, Doves and Eagles, Taxonomic Tangles, Some Columbine Cousins, The Species, Hybrids and Curiosities, Sources of Seed, Glossary, Bibliography, and Index. Excellent photography and the watercolors are beautiful.

LEWIS J. MATTHEWS. 2002. **The Protea Book: A Guide to Cultivated Proteaceae.** (ISBN 0-88192-553-5, pbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $34.95, 184 pp., 286 color photos, 6 × 9".

Contents.—Acknowledgments, Introduction, Cultivating proteas, Proteas in the garden, Commercial cultivation, Identification, Glossary, References, and Index. This beautiful 184-page guidebook covers most of the cultivated members of Proteaceae family not just the genus *Protea*.

Ethnobotanical/Economic/Medicinal/Useful Plants/Toxic

JEAN H. LANGENHEIM. 2003. **Plant Resins: Chemistry, Evolution, Ecology, and Ethnobotany.** (ISBN 0-88192-574-8, pbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $49.95, 612 pp., 47 color photos, 30 b/w photos, 70 line drawings, 4 maps, 4 tables, 7 3/8" × 10 3/8".

Contents.—Preface, Acknowledgments, **1)** What Plant Resins Are and Are Not, **2)** Resin Producing Plants, **3)** How Plants Secrete and Store Resin, **4)** Amer: Resins Through Geologic Time, **5)** Ecological Roles of Resins, **6)** The Ethnobotany of Resins, **7)** Oleoresins, **8)** Fragrant and Medicinal Balsams, **9)** Varnish and Lacquer Resins, **10)** Miscellaneous Resins, and **11)** Future Use of Resin. **Appendix 1:** Resin Producing Conifers, **Appendix 2:** Resin-Producing Angiosperms, **Appendix 3:** Skeletons of Characteristic Components of Fossil Resins, **Appendix 4:** Age, Location, and Plant Source of Amber Deposits, **Appendix 5:** Common Names, Plant Sources, and Uses of Resins. Glossary, References, Plant Index, and Subject Index.

I checked to see if *Paulownia tomentosa* (Sapphire Dragon Tree) was listed as a resin-producing angiosperm and it was not. The leaves produce a very sticky resinous substance that is hard to remove from the hands.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org.*

ANATOMÍA COMPARADA DE LA EPIDERMIS FOLIAR EN EL GRUPO DE ESPECIES *SOLANUM SESSILE*, DE LA SECCIÓN *GEMINATA* (SOLANACEAE)

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RESUMEN

Se estudian y describen las características de la epidermis foliar en ambas superficies, de los taxones del Grupo de especies *Solanum sessile*, representados en Venezuela a saber: *Solanum chlamydogynum* Bitter, *S. obovalifolium* Benítez, *S. oppositifolium* Ruiz & Pav., *S. sessile* Ruiz & Pav., *S. triste* Jacq. y *S. turgidum* S. Knapp. Se utilizaron segmentos de aproximadamente 1 cm^2 de la porción media de hojas secas (especimenes de herbario) o frescas y fijadas en FAA al 70%. Fueron aplicadas técnicas anatómicas convencionales para macerado y tinción. Se evalúan las siguientes variables: presencia, tipo, dimensiones y ubicación de estomas; presencia, tipo, longitud, ubicación y densidad de tricomas; forma y grosor de la pared de las células epidérmicas normales e índice estomático. Los resultados muestran diferencias en algunas de las características anatómicas consideradas, especialmente las referidas a los tipos tricomáticos y a la ubicación de estomas. Dichos resultados se comparan y han permitido la separación de las especies mediante una clave.

ABSTRACT

Epidermal characteristics of leaf blades were studied and described from taxa belonging to the species Group containing *Solanum sessile* represented in Venezuela by the following species: *Solanum chlamydogynum* Bitter, *S. obovalifolium* Benítez, *S. oppositifolium* Ruiz & Pav., *S. sessile* Ruiz & Pav., *S. triste* Jacq. and *S. turgidum* S. Knapp. Middle portions of leaf blades were sampled from herbarium specimens and from fresh plant material fixed in FAA 70%. Conventional anatomical procedures for macerations and staining were used. The following criteria were evaluated: presence, type, dimension and location of stomata; presence, type, length, location and density of trichomes; shape and thickness of the wall of normal epidermal cells, and stomatal index. Results show there are differences in some anatomical characteristics between species especially with regards to trichome types and the location of stomata. These characteristics can be used to identify collections of *Solanum* to the species level. A key to the species of *Solanum* section *Geminata* using these characters is presented.

La Sección *Geminata* del género *Solanum* con 122 especies acomodadas en 16 grupos (Knapp 2002), es una de las secciones dentro del género con mayor número de especies, localizadas principalmente en regiones tropicales de América del Sur y con unas pocas especies representadas en el Viejo Mundo; en Venezuela están presentes 34 especies constituyendo el 23% del total mundial

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y el 32% del total de especies del género *Solanum* en Venezuela (105). Dichas especies estan ampliamente distribuídas, principalmente en selvas húmedas primarias de los pisos meso y microtémicos y en selvas semideciduas y secundarias de los pisos macrotérmicos (Knapp 2002).

Las especies que conforman esta sección exhiben caracteres morfológicos, que en términos generales pueden ser utilizados para el reconocimiento de las mismas como miembros de la sección; tales son su condición de arbustos o árboles, inflorescencias características del tipo cimas helicoidales naciendo opuestas o alternas a una hoja que puede ser geminada o no. La importancia taxonómica de caracteres anatómicos foliares ha sido ampliamente reconocida por muchos investigadores (Solereder 1908; Metcalfe y Chalk 1950; Carlquist y Holt 1961).

Entre dichos caracteres, los estomas que varían en forma, número, orientación y arreglo de las células subsidiarias que los rodean, han desempeñado un papel importante en los procesos evolutivos de las especies vegetales, desde el punto de vista anatómico y taxonómico, lo cual ha justificado su estudio por líneas diferentes y en diversas familias, como lo indicado por Ahmad (1964) quien realizando estudios epidérmicos en 28 especies pertenecientes al género *Solanum*, encontró mayor frecuencia estomática en especies de dicho género comparado con otros géneros, reportando anomalías estomáticas en algunas especies tales como en: *S. macranthum* Dunal, *Solanum nigrum* L., y *Solanum decorticans* Sendtn.

En 1979 Bessis y Guyot estudiaron estomas en miembros de algunas tribus de las Solanaceae, concluyendo que la distribución de tipos de estomas puede ser utilizada para establecer divisiones sistemáticas y sugerir relaciones filogenéticas entre los miembros de dicha familia. Rashib y Beg (1989) elaboraron una clave foliar, como herramienta taxonómica, para algunas especies de la familia Solanaceae, en la que incluyeron características de estomas y tricomas. También los tipos tricomáticos así como su densidad y frecuencia, han sido de alto valor diagnóstico para la definición de las especies, carácter que ha sustentado la clasificación infragenérica dentro de *Solanum* establecida por Seithe (1962, 1979). Dada la utilidad de los caracteres anátomicos foliares como rasgos de valor diagnóstico, en el presente trabajo se estudian y describen las características de la epidermis foliar en ambas superficies, de los taxones del Grupo de especies *Solanum sessile* representados en Venezuela a saber *Solanum chlamydogynum* Bitter, *S. obovalifolium* Benítez, *S. oppositifolium* Ruiz & Pav., *S. sessile* Ruiz & Pav., *S. triste* Jacq. y *S. turgidum* S. Knapp. Los caracteres evaluados y los resultados obtenidos se comparan intentando extraer información anatómica destacable entre las especies.

MATERIALES Y METODO

El material estudiado procede de colecciones de herbario y de aquel fresco fijado

en FAA, según como se enumera en el Anexo 1. Se utilizaron segmentos de aproximadamente 1 cm^2 de la porción media de hojas pertenecientes a exsiccatas del Herbario Victor Manuel Badillo, Universidad Central de Venezuela (MY) o fijadas directamente en FAA al 70% (Formalina, ácido acético glacial, etanol 70%). En el primer caso, previo al estudio anatómico, las secciones de hoja fueron hidratadas sumergiéndolas en agua hirviente por 5-10 min. Para estudiar las características de la epidermis foliar, se realizaron macerados de la porción media de la lámina, colocando segmentos de aproximadamente 1 cm^2 (que incluyeran nervaduras) en una solución de hipoclorito de sodio 5,25% (cloro comercial) o en ácido nítrico 5%–ácido crómico 5% (1:1), en una estufa a 56–58° C. Luego se realizó un lavado profuso de la epidermis con agua destilada y se tiñó con azul de toluidina acuosa 0.5%, para finalmente montarla en agua-glicerina (1:1).Las láminas se observaron y fotografiaron con un microscopio binocular marca Leitz. Además, se realizaron algunas mediciones con la ayuda de un ocular micrometrado. La caracterización cualitativa y cuantitativa se ha obtenido mediante el análisis de las siguientes variables: Presencia, tipo, dimensiones y ubicación de estomas; presencia, tipo, longitud, ubicación y densidad de tricomas; forma y grosor de la pared de las células epidérmicas normales, etc. Además se determinó el índice estomático (I.E) mediante la siguiente formula establecida por Salisbury (1927)

$$I.E = \frac{\text{n° de estomas (S)}}{\text{n° de estomas (S)} + \text{n° de células epidérmicas (E)}} \times 100$$

RESULTADOS

Solanum chlamydogynum Bitter

Las células de la epidermis adaxial tienen contornos poligonales (Fig. 1) y paredes celulares ligeramente engrosadas, mientras que las de la epidermis abaxial poseen contornos poligonales a ligeramente ondulados y paredes delgadas (Fig. 2). Hoja anfiestomática; estomas de la epidermis adaxial principalmente del tipo anisocíticos (largo 25,03 µm y ancho 14,67 µm), ubicados próximos y sobre las nervaduras (Fig. 1), aunque pueden aparecer algunos aislados en la lámina. En la epidermis abaxial los estomas son con mayor frecuencia anisocíticos (I.E.= 19,78–22,51); largo 19,27–23,2 µm y ancho 14,83–17,2 µm). Presencia de tricomas protectores y glandulares en ambas epidermis. En la epidermis adaxial, los tricomas protectores aparecen simples y ramificados sobre la lámina y nervaduras en muy baja densidad (0,22/mm^2); los protectores simples son multicelulares uniseriados con ápice agudo y con longitud y número variable de células. Los protectores ramificados (multicelulares) en su mayoría tienen dos ramas que emergen al mismo nivel (una más desarrollada que la otra), aunque también se observan con mayor cantidad de ramas. En la epidermis

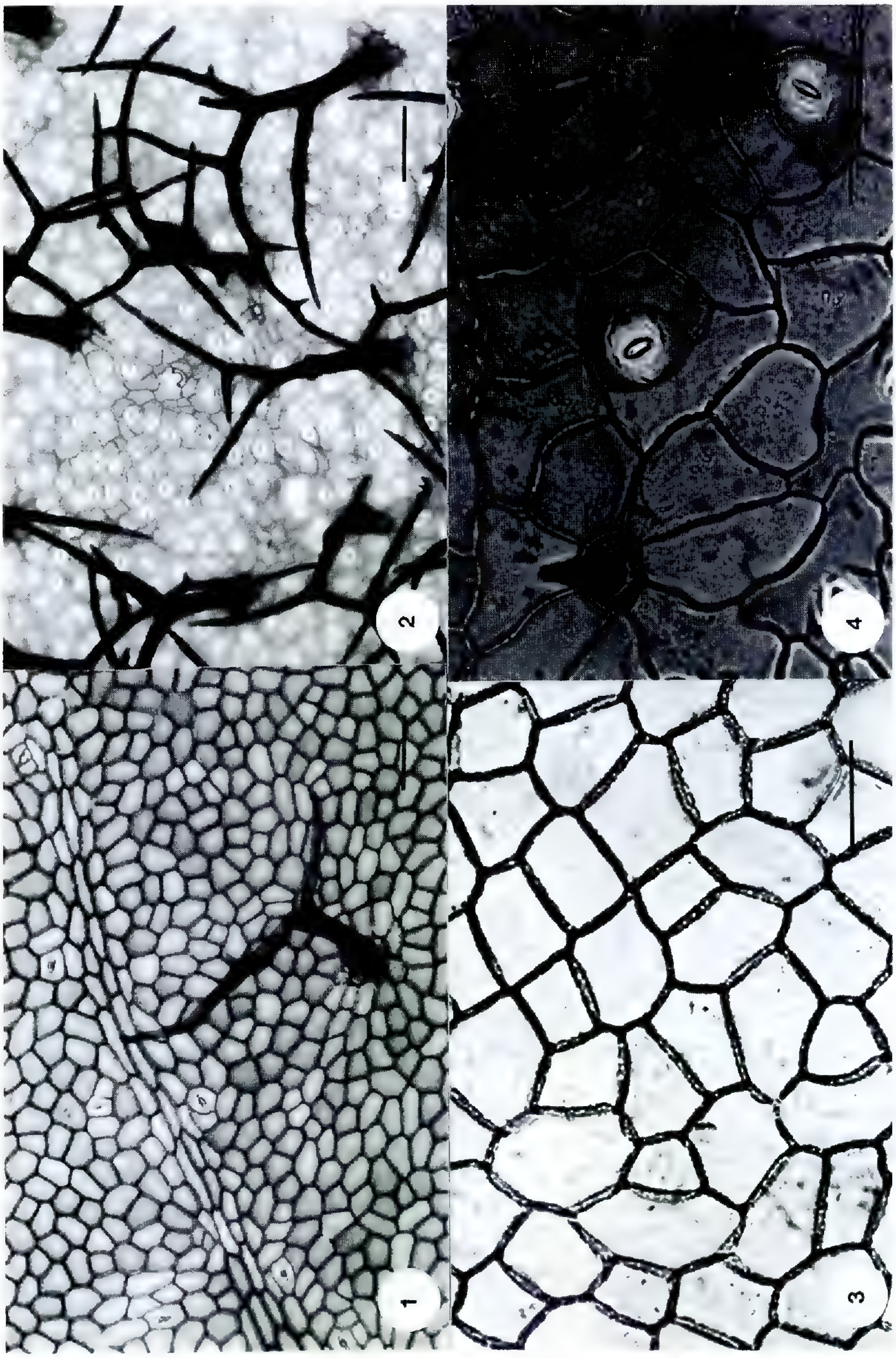
Anexo 1. Relación del material garante utilizado para el estudio anatómico.

Colector	N° colección y herbario de depósito	Especie	Localización geográfica	Condición del Material
Ruiz Zapata, Thirza. et al.	*4568* MY	*S. chlamydogynum*	Edo. Aragua- Municipio Tovar. Selva nublada	De herbario
Benítez de Rojas C. E. et al.	*6193* MY	*S. chlamydogynum*	Edo. Aragua- Municipio Tovar. Selva nublada	FAA 70%
Badillo, Víctor M.	*3848* MY	S. obovalifolium M.B. Iragorry. Selva nublada	Edo. Aragua- Municipio	De herbario
Benítez de Rojas C.E. et al.	*4908* MY	*S. obovalifolium* nublada	Edo. Aragua- Municipio M. B. Iragorry. Selva	De herbario
Morillo, G. y M. Hasegawa	*5132* MY	*S. oppositifolium* húmeda macrotérmica	Edo. Amazonas- MunicipioAtures. Selva	De herbario
Benítez de Rojas C.E. et al.	*2401* MY	*S. sessile* nublada	Edo. Mérida- Municipio Arzobispo Chacón. Selva	De herbario
Benítez de Rojas C.E. et al.	*805* MY	*S. triste*	Edo. Sucre.-Distrito Montes. Selva nublada	De herbario
Knapp, S. et al.	*6763* MY	*S. turgidum*	Edo. Sucre-Península de Paria. Selva nublada	De herbario

abaxial, los tricomas protectores son todos multicelulares ramificados (Fig. 2) y se encuentran en una alta densidad sobre lámina y nervaduras (8,84–15,94/ mm^2); los mismos son de mayor tamaño que los de la epidermis superior y generalmente tienen dos ramas principales que emergen a un mismo nivel, las que luego se ramifican en un número variable de ramas de orden mayor (Fig. 2). Los tricomas glandulares en las dos epidermis son multicelulares simples (D adaxial= 2,39/ m^2; D abaxial= 1,47–2,78/ mm^2), no distinguiéndose claramente el número de células que los conforman.

Solanum obovalifolium Benítez

La epidermis adaxial presenta células con contornos poligonales, de paredes ligeramente engrosadas (Fig. 3), mientras que la abaxial está formada por células de paredes ligeramente onduladas y más delgadas. Hoja hipostomática (I.E.= 7,73–12,5); estomas con mayor frecuencia del tipo anisocíticos, aunque también se observan diacíticos (largo 19,5–20,1 µm y ancho 16,4–16,5 µm). En la epidermis adaxial se observan tricomas glandulares. En la epidermis abaxial están presentes tricomas protectores y glandulares, con una densidad de 3,27 y 4,75–7,2/ mm^2 respectivamente. Los primeros son simples, cortos y unicelulares (Fig. 4) y los segundos son simples, cortos, multicelulares uniseriados; sin embargo, no fue posible distinguir el número de células que lo conforman.



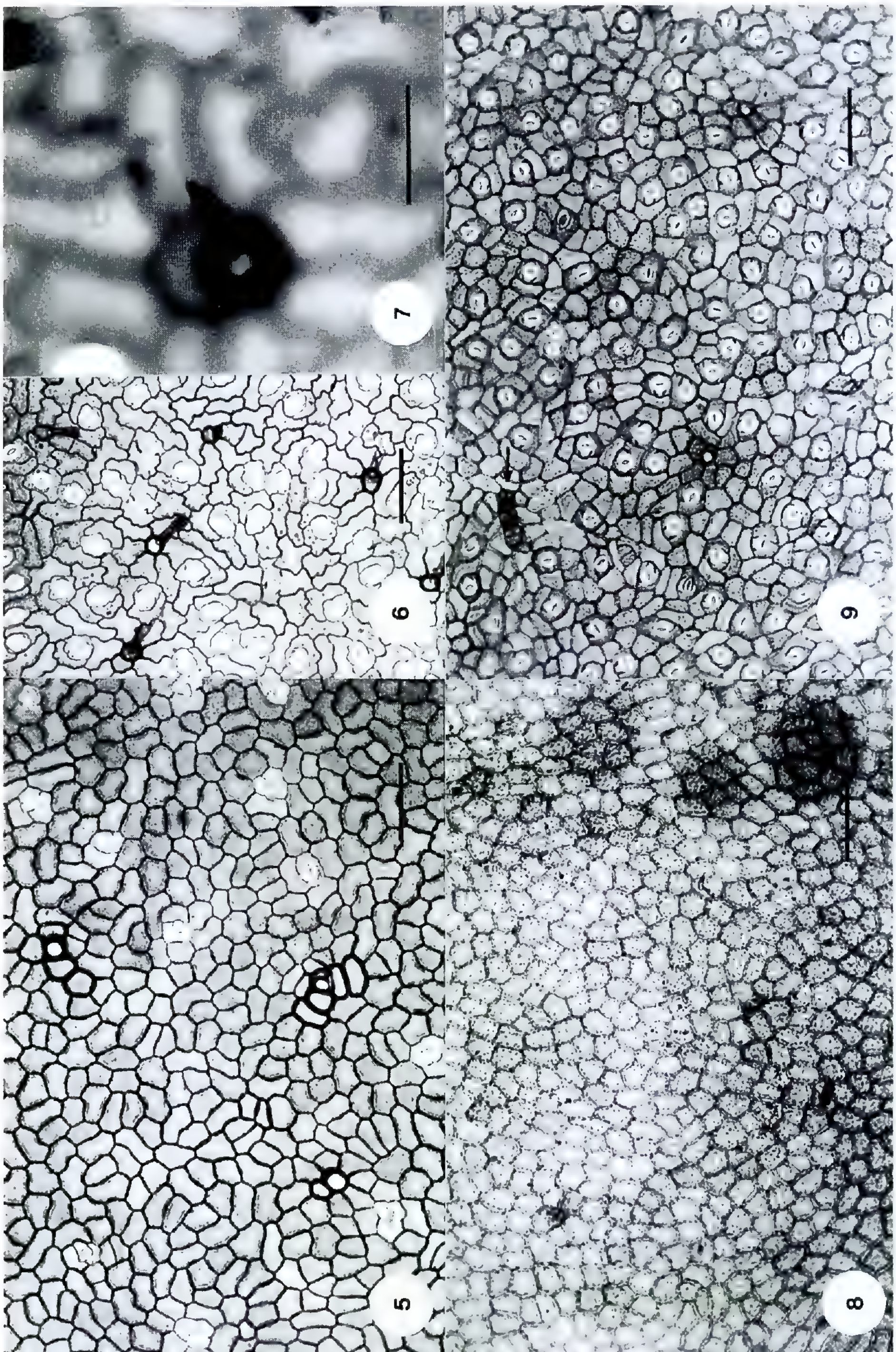
FIGS. 1–4. *Solanum chlamydogynum* **Figs. 1–2. 1.** Epidermis adaxial 100×. Obsérvese estomas próximos a las nervaduras, forma de las células epidérmicas normales y tricoma protector ramificado. **2.** Epidermis abaxial 100×. Véase tricomas protectores ramificados y forma de las células epidérmicas normales. *Solanum obovalifolium* **Figs. 3–4. 3.** Epidermis adaxial 400×. **4.** Epdermis abaxial 400×. Nótese tricoma protector simple unicelular. Barra de escala: Figs. 1–2 = 100 μm; Figs. 3–4 = 10 μm

Ha sido indicado (Metcalfe y Chalk 1979), que el tricoma glandular es de naturaleza delicada, por lo que éstos son mejor detallados en material vivo o en especímenes tratados mediante secado por punto crítico.

Solanum oppositifolium Ruiz & Pav.
La epidermis adaxial presenta células epidérmicas normales con contornos poligonales a ligeramente ondulados y paredes celulares ligeramente engrosadas, mientras que la epidermis abaxial está formada por células con contornos ondulados y paredes relativamente delgadas. Hoja anfiestomática (I.E. superior 4,01; I.E. inferior 13,69); estomas del tipo anisocíticos en ambas epidermis (Fig. 5), siendo de largo 25,37 µm y ancho 15 µm en epidermis adaxial y de largo 24,37 µm y ancho 18,5 µm en la epidermis abaxial. Presencia de tricomas en ambas epidermis. En la superior todos se encuentran desprendidos, observándose únicamente las células basales (D= 0,83/ mm^2), por lo que se hace necesario repetir el procedimiento con una maceración más suave. Sobre las nervaduras se observan tricomas protectores simples, cortos y unicelulares. En la epidermis inferior se encuentran en mayor frecuencia tricomas glandulares alargados, de forma columnar, ubicados en toda la lámina (D=2,43/ mm^2) y sobre nervaduras; la parte inferior de este tricoma se tiñe intensamente con el azul de toluidina (Figs. 6,7). Ubicados principalmente sobre las nervaduras o próximos a ellas, se encuentran tricomas protectores cortos unicelulares, aunque en ocasiones pueden observarse sobre la lámina.

Solanum sessile Ruiz & Pav.
La epidermis adaxial está constituida por células de contornos poligonales y paredes celulares relativamente gruesas (Fig. 8), mientras que la abaxial tiene células epidérmicas normales con contornos poligonales y paredes ligeramente engrosadas, pero más delgadas que la epidermis superior (Fig. 9). Ambas epidermis presentan ornamentaciones a manera de papilas en la cutícula, siendo éstas con mejor definición en la epidermis superior (Fig. 8). Hoja anfiestomática; estomas de la epidermis adaxial únicamente presentes en muy baja frecuencia sobre las nervaduras principales o muy cerca de éstas (largo 29,67 µm y ancho 11,78 µm). Estomas de la epidermis abaxial principalmente del tipo anisocítico (Fig. 9) (I.E: 13,37; largo 23,1 µm y ancho 14,6 µm). Presencia de tricomas glandulares simples, multicelulares uniseriados, robustos, ubicados sobre la lámina y nervaduras de ambas epidermis (Fig. 9) (D adaxial =0,82/ mm^2 y D abaxial =4,4/ mm^2).

Solanum triste Jacq.
Células epidérmicas normales, de la epidermis adaxial, con contornos ligeramente ondulados y paredes relativamente delgadas. En la epidermis abaxial, las células tienen contornos ondulados y paredes delgadas (Fig. 11). Hoja anfiestomática; epidermis superior con estomas principalmente anisocíticos



FIGS. 5–9. *Solanum oppositifolium* **Figs. 5–7. 5.** Epidermis adaxial 100×. Nótese la presencia de estomas en la lámina. **6.** Epidermis abaxial 100×. Vista general. **7.** Detalle de tricoma protector simple unicelular 400×. *Solanum sessile* **Figs. 8–9. 8.** Epidermis adaxial 100×. **9.** Epidermis abaxial 100×. Nótese el tricoma glandular simple (indicado con flecha). Barra de escala: Figs. 5–6, 8–9= 100 μm; Fig. 7=10 μm

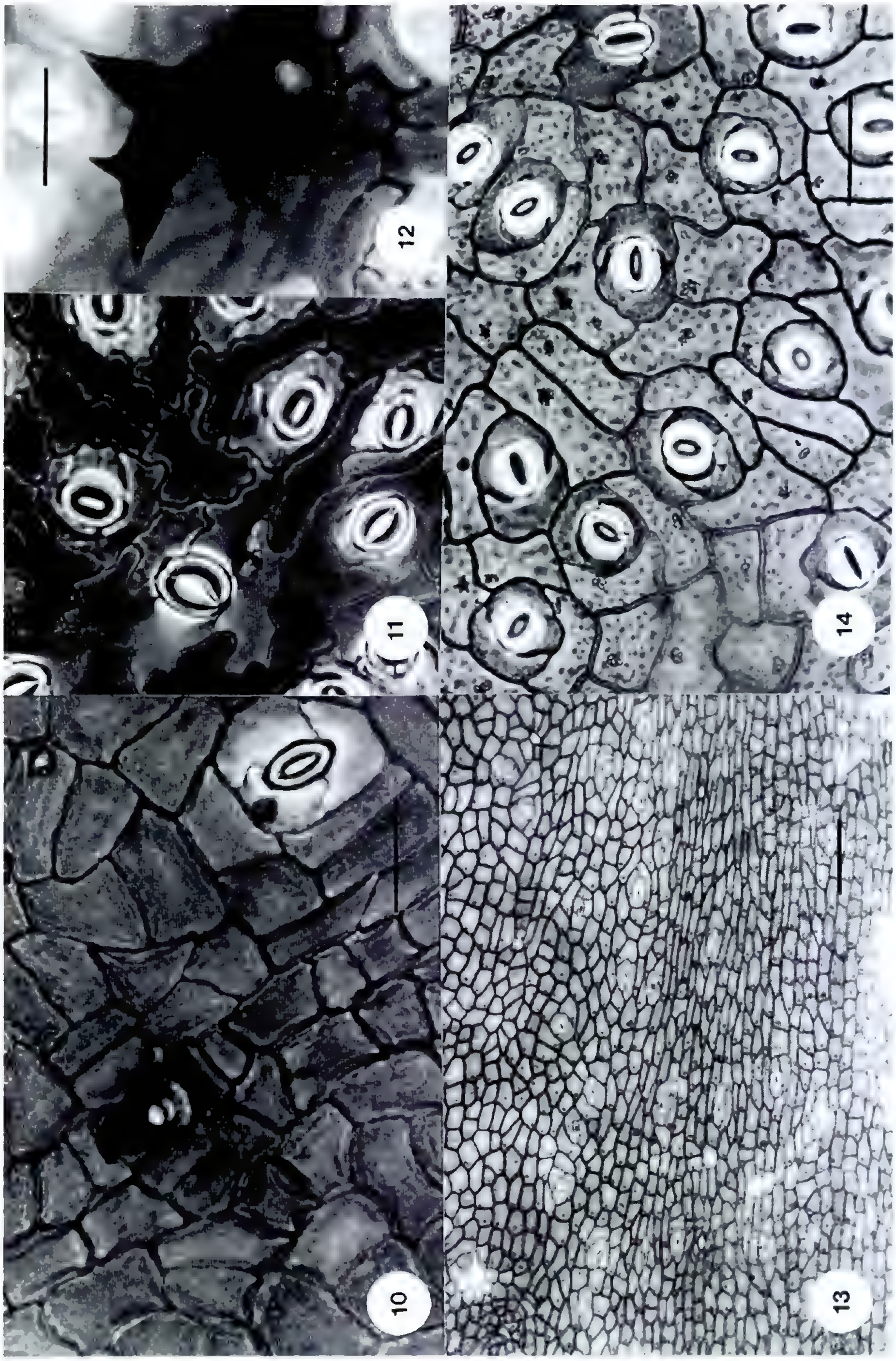
próximos a las nervaduras (Fig. 10) (largo 22,77 µm y ancho 15,07 µm) y epidermis inferior con estomas en su mayoría anisocíticos (Fig. 11) (largo 24,67 µm y ancho 18,43 µm) ubicados en la lámina (I. E. = 14,73). Tricomas protectores y glandulares presentes en ambas epidermis sobre la lámina y nervaduras. Los primeros son de dos tipos, simples cortos, multicelulares uniseriados (Fig. 10 y 12) y ramificados cortos (multicelulares, con ramas cortas cercanas a la base), siendo este último tipo de tricoma más ramificado en la epidermis inferior (Fig. 12). La densidad de los tricomas protectores fue de 6,08/mm^2 en la superficie adaxial y 13/ mm^2 en la superficie abaxial. Los tricomas glandulares son simples cortos, multicelulares uniseriados (D=1,26/ mm^2 en ambas epidermis).

Solanum turgidum S. Knapp

Células epidérmicas normales de la epidermis adaxial con contornos poligonales a ligeramente ondulados y paredes relativamente delgadas (Fig. 13), mientras que las de la epidermis inferior tienen contornos medianamente ondulados y paredes delgadas (Fig. 14). Hoja anfiestomática; estomas principalmente del tipo anisocítico, los de la epidermis adaxial ubicados próximos o sobre las nervaduras (Fig. 13) (largo 20,53 µm y ancho 13,3 µm), muy aisladamente se encuentran estomas dispersos sobre la lámina (Fig. 13). Los estomas de la epidermis abaxial se encuentran en mediana densidad sobre toda la lámina (Fig. 14) (I.E. 11,37; largo 19,57 µm y ancho 14,8 µm). Presencia de tricomas glandulares en ambas epidermis. En la superior, los mismos se encuentran colapsados, dispersos en toda la lámina (D=0,33/ mm^2). En la cara abaxial se observan constituidos por pie unicelular y cabeza formada por varias células (D=1,1/mm^2).En esta misma epidermis, sobre las nervaduras principales se observan tricomas protectores simples, cortos unicelulares. El pie unicelular del tricoma glandular se tiñe más intensamente con el colorante, lo que dificulta su observación.

CLAVE DE LAS ESPECIES

1. Tricomas únicamente glandulares _____ **Solanum sessile**
1. Tricomas protectores y glandulares
   2. Tricomas protectores siempre simples y cortos en la epidermis abaxial.
      3. Hoja hipoestomática _____ **Solanum obovalifolium**
      3. Hoja anfiestomática.
         4. Estomas en la epidermis adaxial ubicados en toda la lámina _____ **Solanum oppositifolium**
         4. Estomas de la epidermis adaxial sólo próximos a/o sobre las nervaduras _____ **Solanum turgidum**
   2. Tricomas protectores ramificados, excepcionalmente simples en la epidermis abaxial.
      5. Tricomas con ramas cortas. Paredes ce ulares onduladas en la epidermis abaxial _____ **Solanum triste**
      5. Tricomas con ramas largas. Paredes celulares poligonales a ligeramente onduladas en la epidermis abaxial _____ **Solanum chlamydogynum**



FIGS. 10–14. *Solanum triste* **Figs. 10–12. 10.** Epidermis adaxial 400 ·. Nótese estomas cercanos a la nervadura y tricoma protector simple. **11.** Epidermis abaxial 400 ·. Obsérvese paredes celulares onduladas. **12.** Detalle de tricoma protector ramificado corto 400×. *Solanum turgidum* **Figs. 13–14. 13.** Epidermis adaxial. 100×. Vista frontal en donde se observan estomas en la nervadura. **14.** Epidermis abaxial 400 ·. Vista general. Barra de escala: Figs. 10–12, 14= 10 μm; Fig. 13= 100 μm.

CONCLUSIONES

Rasgos del sistema dérmico representan caracteres útiles para la caracterización de las hojas en especies de *Solanum* sección *Geminata*, pudiendo ser de ayuda en la identificación de especies, lo cual ha sido indicado para otros géneros de Solanaceae (De Pasquale et al. 1991). El tipo de hoja según la ubicación de los estomas en ambas epidermis además de su distribución bien sea en la lámina o cerca de las nervaduras, representan caracteres de valor diagnóstico para las especies estudiadas. Respecto a la ubicación de los estomas, este rasgo permitió diferenciar las especies, no así el tipo de estoma ya que se evidenció similitud en todas las especies estudiadas. Los tricomas hasta ahora observados, básicamente protectores, son de valor para la diagnosis de las especies, carácter que ha sustentado la clasificación infragenérica dentro de *Solanum* (Seithe 1962, 1979). Aunque la mayoría de los tricomas glandulares se colapsan con la metodología utilizada en este estudio, no se consideró realizar un examen más detallado de ellos, ya que vistos al microscopio óptico son muy similares en todas las especies. Caracteres cuantitativos como densidad y longitud de tricomas reflejan variación condicionada por el ambiente y edad de la planta y raramente pueden ser usados para diferenciaciones taxonómicas (Metcalfe y Chalk 1950); por lo que dichos caracteres se han considerado como rasgos complementarios a la caracterización de las especies. El reconocimiento anatómico de la epidermis foliar como una fuente de evidencias taxonómicas ha permitido separar las especies mediante una clave.

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BOOK NOTICES

Ethnobotanical/Economic/Medicinal/Useful Plants/Toxic

JOHN and MARGARET CANNON. 2003. **Dye Plants and Dying.** (ISBN 0-88192-572-1, pbk.). Timber Press, Inc. 133 S.W. Second Ave, Suite 450, Portland, OR 97204-3527, U.S.A. (Orders: www.timberpress.com, mail@timberpress.com, 503-227-2878, 1-800-327-5680, 503-227-3070 fax). $19.95, 129 pp., 48 color paintings, 7 3/16 × 9 3/4".

This is a lovely book deserving of a readership beyond those mainly concerned with the fiber arts. For the historian and ethno-botanist the use of plants for color arose in the far distant past. For the botanical novice, the simple descriptions of the plants and the glossary and checklist of scientific names offer a good introduction to the science. There is material for the conservationist and the biochemist. For the art lover, the plates themselves make the book a delight

This combination of art and science makes this book important. It offers exact instructions for craft dyers and accurate botanical information about the plant sources of the coloring material. The illustrations are accurate and beautiful The color samples and mordant symbols are incorporated into the design of the plate so as to make a pleasing whole. This is an excellent book.

It covers a wide range of natural plant dyes and provides accurate botanical information about each plant. *Ruth Ginsburg, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A*

MARIANNA APPEL KUNOW. 2003. **Maya Medicine: Traditional Healing in Yucatán.** (ISBN 0-8263-2864-4, hbk.). University of New Mexico Press, 1720 Lomas Blvd. NE, 1 University of New Mexico, Albuquerque, NM 87131-0001, U.S.A. (Orders: 800-249-7737, 505-277-9270 fax, unmpress.com). $29.95, 160 pp., 36 line drawings, 6 × 9".

Review forthcoming in Sida 21(1), 2004.

JOHN BOIK. 2001. **Natural Compounds in Cancer Therapy: Promising Nontoxic Antitumor Agents from Plants & Other Natural Sources.** (ISBN 0-9648280-1-4, pbk.). Oregon Medical Press, 315 10th Avenue N, Princeton, MN 55371, U.S.A. (Orders: 800-610-0768, 612-395-5239 fax, sales@ompress.com, www.ompress.com). $32.00, 520 pp., 8 1/2 × 11".

Review forthcoming in Sida 21(1), 2004.

DOCUMENTED CHROMOSOME NUMBERS. 2003: 2. CHROMOSOME NUMBERS OF THE RARE TEXAS SPECIES, *ARIDA BLEPHAROPHYLLA* AND *A. MATTTURNERI* (ASTERACEAE: ASTEREAE)

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Meiotic chromosome counts for the exceedingly rare Texas species, *Arida blepharophylla* (A. Gray) Morgan & Hartman and *A. mattturneri* B.L. Turner & Nesom (cf. description in this issue, p. 1418) are reported, both being diploid with $2n = 5$ pairs. The two taxa were found growing together or near each other in 'Blumberg Canyon', ca. 2 mi NNW of Ruidosa, Presidio Co., Texas.

Vouchers for the collections: ***Arida mattturneri***, *Matt Turner 100* (NY, SRSC, TEX); ***Arida blepharophylla***, *B.L. Turner 23-91* (SRSC, TEX).

Arida blepharophylla (= *Machaeranthera gypsitherma* Nesom, Vorobik & Hartman) was also previously counted as diploid ($2n = 5$ pairs) from a population in the state of Chihuahua, Mexico (Nesom et al. 1990). Free hand drawings of the chromosomes, from buds collected on 28 Aug 2003 by B.L Turner, are illustrated in Fig. 1.



Fig 1. Meiotic chromosomes of *Arida mattturneri* (left side, 5 bivalents at metaphase 1); and *A. blepharophylla* (5 bivalents and 3 centric fragments, at diakinesis)

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Nesom, G.L., L.A. Vorobik, and R.L. Hartman. 1990. The identity of *Aster blepharophylla* (Asteraceae: Astereae). Syst. Bot. 15:638–642.

BOOK NOTICES

Ethnobotanical/Economic/Medicinal/Useful Plants/Toxic

KELVIN CHAN and HENRY LEE (ed.). 2002. **The Way Forward for Chinese Medicine.** (ISBN 0 415 27720-5, hbk.). Taylor & Francis, 11 New Fetter Lane, London EC4P 4EE, UK and 29 West 35th Street, New York, NY 10001, U.S.A. (Orders: info@tandf.co.uk, www.tandf.co.uk, 44 (0) 207 583 9855, fax 44 (0) 207-842-2298, standing orders call 44 (0)1264 343071. **US and Canada Customers:** By mail: Taylor & Francis Customer Service, 10650 Toebben Drive, Independence, KY 41051, U.S.A., Toll Free Tel: 1-800-634-7064, Toll Free Fax: 1-800-248-4724, email: cserve@routledge-ny.com). $96.00, 191 pp., 7" × 10".

The Way Forward for Chinese Medicine is basically an introduction to Chinese Traditional Medicine. It takes a look at acupuncture, qigong and related practice, as well as chemical treatment using Chinese medicinal materials for the prevention and cure of illness. The book also examines the modern use of Chinese Traditional Medicine in cancer research, issues of toxicity, procedures for identification of Chinese herbal materials using DNA fingerprinting, and how modernization of Chinese medicine is taking place in China

Contents.—**Section One: Some Key Issues in Chinese Medicine; 1)** The Historical Evolution of Chinese Medicine and Orthodox Medicine in China; **2)** Philosophical Aspects of Chinese Medicine from a Chinese Medicine Academician; **3)** The Theory and Application of Functional Food in Chinese Medicine; **4)** Understanding the Toxicity of Chinese Herbal Medicinal Products; **Section Two: Special Aspects of Clinical and Scientific Practice** in **Chinese Medicine; 5)** The Practice of Chinese Medicine in TCM-KLINIC KÖTZTING in Germany; **6)** The Practice of Chinese Medicine in the National Health; Service Environment in the United Kingdom; **7)** Treatment of Irritable Bowel Syndrome Using Chinese Medicine; **8)** The Progress of Using Chinese Herbal Medicines in Cancer Research; **9)** DNA Techniques for the Authentication of Chinese Medicinal Materials; **Section Three: Progress of Chinese Medicine and Related Practice in Some Countries and Regions; 10)** The Progress of Chinese Medicine in Australia; **11)** The Progress of Chinese Medicine in Mainland China; **12)** The Progress of Chinese Medicine in Some Countries **in** Europe: Belgium, Germany and Holland; **13)** The Progress of Chinese Medicine in Hong Kong SAR, China; **14)** The Progress of Kampo Medicine in Japan; **15)** The Progress of Chinese Medicine in Taiwan; **16)** The Progress of Chinese Medicine in the United Kingdom; **17)** The Progress of Chinese Medicine in the United States of America; **Section Four: Concluding Issues; 18)** A Curriculum Model for Teaching and Training Chinese Medicine in English; **19)** An Orthodox Practitioner's View of Chinese Medicine; **20)** The Way Forward for Chinese Medicine; and Index.

ASPECTOS ECOLÓGICOS Y ESTADO DE CONSERVACIÓN DE *MAMMILLARIA THERESAE* (CACTACEAE)

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RESUMEN

Se analizan algunos aspectos de la ecología, distribución y estado de conservación de *Mammillaria theresae* Cutak (Cactaceae), una especie endémica a una pequeña área de la Sierra de Coneto, localizada en el centro del estado de Durango (México) al oriente de la Sierra Madre Occidental y en el límite occidental del Desierto Chihuahuense. Por su condición de serranía aislada, la Sierra de Coneto es de interés ecológico y fitogeográfico; es la única localidad conocida para *M. theresae* y para un género recientemente descrito (*Megacorax*, Onagraceae). *Mammillaria theresae* es altamente apreciada por coleccionistas de especies exóticas; se conoce localmente con los nombres de peyote y peyotillo, y su población está siendo mermada debido a la ampliación de un camino. Se evaluó el estado actual de la población de *M. theresae* mediante muestreos de vegetación y monitoreo de 126 individuos en siete sitios. La especie crece en una superficie de 1.7 ha en manchones distribuidos en un área de 2.5 km^2, principalmente sobre sustrato rocoso. Debido a su distribución restringida, tamaño de población y disturbio y fragmentación de su hábitat, *M. theresae* califica en la categoría de en peligro de extinción. La información generada puede ser aplicada en el diseño de un plan para la protección de la especie

PALABRAS CLAVE: *Mammillaria*, Cactaceae, conservación, endemismo, extinción, Durango

ABSTRACT

We analyzed some aspects of the ecology, distribution, and conservation status of *Mammillaria theresae* Cutak (Cactaceae), a narrow endemic to the Sierra de Coneto in central Durango, Mexico. Because its isolation, this sierra has ecological and phytogeographical importance. It is located at the east of the Sierra Madre Occidental and on the western boundaries of the Chihuahuan Desert, and it is the only known locality for *M. theresae* and for a genus recently described (*Megacorax*, Onagraceae). *Mammillaria theresae* is a highly appreciated species which is locally known as peyote and peyotillo. Its population is being severely affected mainly due to the construction of a road. We evaluated the present situation of the species as well as the environmental factors with which it is related. We studied the population size from seven plots sampled across its distribution area. Density, cover and frequency of *M. theresae* and its associated species were measured, and 126 individual plants were monitored to record its fenology and dispersal mechanisms. The species grows over 1.7 ha distributed over approximately 2.5 square km along an elevational range between 2180 and 2320 m a.s.l. Because its restricted distribution, size of the population, and increasing destruction and fragmentation of its habitat, it is considered as an endangered species. This information can be used to design a plan to protect the species from further decline.

KEY WORDS: *Mammillaria*, Cactaceae, conservation, endemism, extinction, Durango, Mexico.

Las cactáceas representan un recurso único por su importancia ecológica y económica. Son apreciadas como plantas decorativas, por sus formas raras y caprichosas y por sus flores vistosas y exóticas, lo que las hace codiciadas por aficionados y coleccionistas (Sánchez-Mejorada 1979, 1982, 1982a; Becerra 2000; Benítez y Dávila 2002). Además de su importancia como ornamentales, también se utilizan como alimento, como medicinales y como materia prima en la industria rural (Rzedowski y Rzedowski 1985). De México se conocen alrededor de 822 especies, de las cuales más de 350 pertenecen al género *Mammillaria*, la mayoría endémicas del país. Algunas cactáceas están entre las plantas más amenazadas del reino vegetal, principalmente porque durante varias décadas han sido objeto de un intenso saqueo de plantas y semillas con el fin de satisfacer el mercado internacional (Benítez y Dávila 2002), y muchas están sujetas a presiones de colecta y a la destrucción de su hábitat. Regularmente tienen tasas de crecimiento muy bajas y ciclos de vida muy largos, y su reproducción es muy lenta sobre todo después de un evento de perturbación (Hernández y Godínez 1994; Arias 1998). En la Norma Oficial Mexicana (NOM-059-ECOL-2001) se reportan 285 especies de cactáceas en alguna categoría de riesgo.

Mammillaria theresae Cutak (Cactaceae) es una especie de distribución restringida a una pequeña área en la Sierra de Coneto, en el estado de Durango (Glass y Foster 1985; Bravo 1991; González et al. 1997). Forma parte de la serie *Longiflorae* (Hunt 1981, 1987), particularmente buscada por la belleza de sus flores, y es altamente apreciada por coleccionistas, particularmente europeos, por su originalidad y rareza (Fig. 1 y 2). La especie aparece por lo menos en 135 sitios de Internet, es cultivada en jardines botánicos de todo el mundo y aparece en catálogos de muchas compañías que la propagan artificialmente para venta. Hasta hace 15 años, era tanta su demanda que la población rural del área la conoce con los nombres de "peyotillo" y "peyote" al considerar erróneamente que su demanda se debía a que la planta posee propiedades alucinógenas.

Está incluida en la Norma Oficial Mexicana como especie amenazada; Vovides (1981) la cita entre las especies en peligro, y en el libro rojo de datos de la IUCN (www.redlist.org) está considerada en la categoría de especies vulnerables. Actualmente su población está siendo afectada por la ampliación del camino entre Coneto y Nuevo Ideal, que será un tramo de la carretera entre Torreón, Coahuila y Culiacán, Sinaloa. El disturbio ocasionado por la ampliación del camino y las actividades de extracción está afectando en forma severa tanto a las poblaciones de *M. theresae* como de otras especies.

El objetivo de este trabajo es contribuir al conocimiento de *M. theresae*, especialmente en lo que se refiere al tamaño y densidad de su población, su distribución, la especificidad de su hábitat y el estado actual en que se encuentra la población.



FIG. 1. *Mammillaria theresae*. Adulto y juvenil.



FIG. 2. Flores de *Mammillaria theresae*.

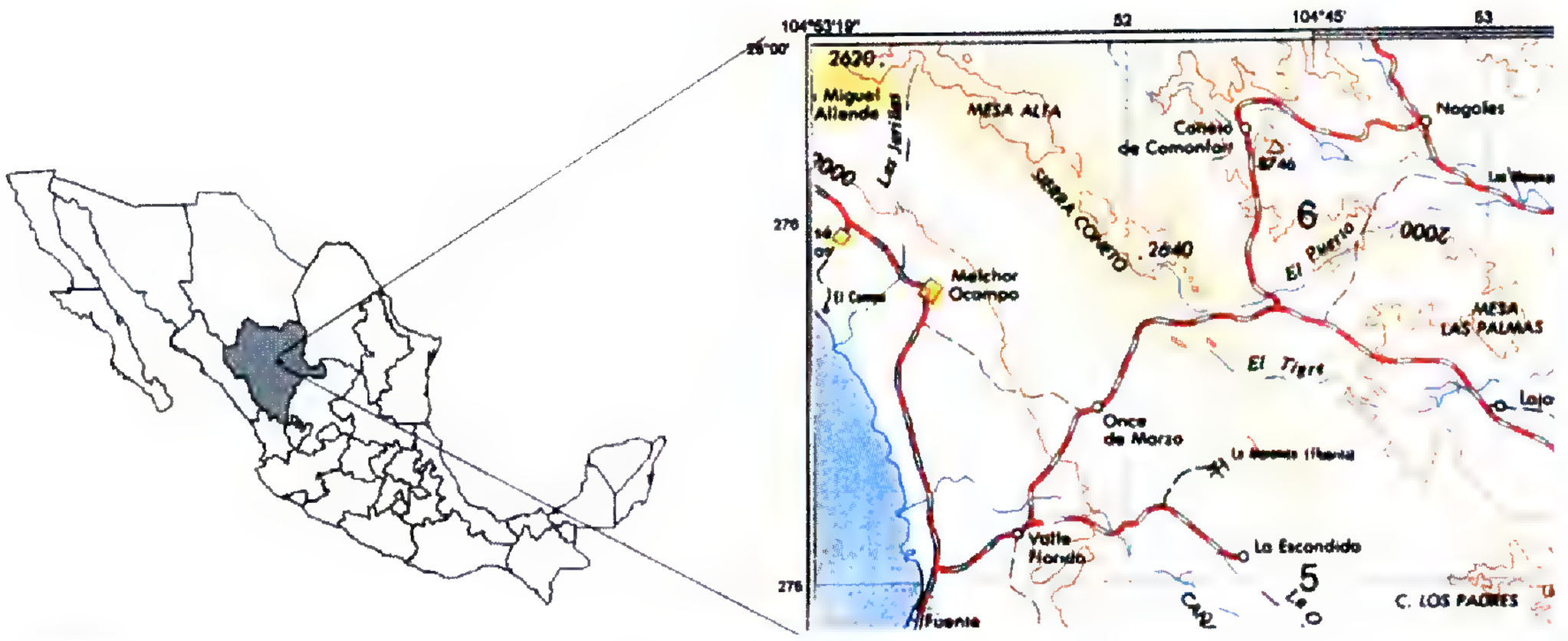


FIG. 3. Ubicación de la Sierra de Coneto, donde se localiza el área de estudio (basado en carta topográfica 1:250 000 de INEGI).



FIG. 4. Habitat de *Mammillaria theresae*. *Nolina juncea* en primer plano, con *Pinus cembroides*.

METODOLOGÍA

Tomando como base la localidad tipo de *M. theresae*, se efectuaron recorridos y observaciones a lo largo de la sierra de Coneto, apoyados en mapas de Instituto Nacional de Estadística, Geografía e Informática (INEGI). Se llevó a cabo una búsqueda intensiva en diferentes épocas del año, particularmente en áreas ecológicamente afines a la zona de donde se tenía reportada la especie.

En la única localidad donde se encontró la especie se detectaron siete poblaciones, cada una de las cuales se recorrió para determinar su superficie. En cada población se trazaron tres líneas Canfield de 20 m (Canfield 1941; citado en Mueller-Dombois y Ellenberg 1974) para cuantificar la cobertura y la frecuencia de *M. theresae* y su flora acompañante, y a lo largo de la línea media en cada lugar se colocó un bastidor de 1 m^2 a través de 10 m para determinar su densidad. Adicionalmente, en cada población se establecieron puntos fijos de muestreo de un metro cuadrado para monitorear la fenología, variación en tamaño y establecimiento de plántulas de esta especie, estudiándose un total de 126 individuos. Se llevaron a cabo colectas botánicas de la flora acompañante; el material se procesó, identificó y depositó en el Herbario CIIDIR y sus duplicados serán posteriormente distribuidos a otros herbarios. Para determinar el estado de conservación de *M. theresae* se consideraron los criterios especificados en la Norma Oficial.

Descripción del área de estudio

La Sierra de Coneto se localiza en los municipios de Nuevo Ideal y Coneto de Comonfort, en el centro del estado de Durango. Es una serranía aislada, ubicada al oriente de la Sierra Madre Occidental y en el límite occidental del Desierto Chihuahuense, entre los 24° 54' y 24° 59' N y los 104° 45' y 104° 49' W; su altitud varía entre los 2100 y los 2700 m s.n.m. (Fig. 3 y 4). El clima del área es templado semiseco (BS_1kw) de acuerdo al sistema de Koeppen, modificado por E. García (1973). La vegetación dominante es un matorral esclerófilo de *Quercus depressipes* y *Arctostaphylos pungens* con *Pinus cembroides*, *Quercus* y *Yucca*. En el estrato herbáceo destacan *Selaginella schaffneri*, *S. rupincola*, *S. pilifera*, *Sedum pringlei* y diversas gramíneas y compuestas. Este tipo de ecosistemas contribuyen a la génesis y al mantenimiento de endemismos y por lo tanto a la riqueza de la flora (Rzedowski 1978). De la zona se conoce también *Megacorax gracielanus*, género y especie descubiertos durante el desarrollo de este proyecto y recientemente descritos (González et al. 2002).

RESULTADOS Y DISCUSIÓN

Distribución y abundancia

Mammillaria theresae tiene una distribución muy restringida. Se localizó únicamente en la zona conocida como Puerto de Coneto y sus alrededores, entre los 2180 y los 2320 m, en una superficie de 1.7 ha distribuidas sobre un área de 2.5

km^2. Se distribuye en siete manchones (poblaciones) de tamaño y densidad muy diversos, en pendientes de 0° a 45° desde la parte media de las laderas hasta el pie de monte, donde es más abundante. Manifiesta preferencia por sitios con fuerte afloramiento rocoso y suelo muy somero o ausente, así como sobre grava; también se localiza debajo de piedras. Crece solitaria o en colonias; la densidad promedio de los individuos en la zona en donde mejor se desarrolla es de 1.2/m^2, aunque llega a alcanzar (incluyendo plántulas y juveniles) hasta 78 plantas/m^2 en el sitio de mayor densidad. En las poblaciones examinadas, *M. theresae* cubre el 0.059% de la superficie y presenta una frecuencia relativa de 1.11% (Cuadro 1).

Al desarrollarse en fisuras de la roca madre, esta especie afronta condiciones de escasa o nula humedad la mayor parte del año, quedando completamente expuesta al sol y al viento. Como resultado de la erosión que está sufriendo el suelo las plantas en ocasiones son arrastradas por las lluvias y la raíz queda al descubierto.

Flora acompañante

Las especies herbáceas que sobresalen tanto en cobertura como en frecuencia relativa son *Selaginella schaffneri* y *S. rupincola*, así como varias gramíneas (Cuadro 1). Las herbáceas con mayor frecuencia en el área pertenecen a las familias Selaginellaceae, Crassulaceae, Portulacaceae, Gramineae, Compositae y Euphorbiaceae. *Mammillaria theresae* se encuentra asociada principalmente a *Sedum pringlei*, *Selaginella schaffneri*, *S. rupincola* y *S. pilifera*, así como a gramíneas, otras herbáceas y musgos.

Los elementos leñosos dominantes en la zona son: *Pinus cembroides*, *Quercus depressipes* y *Arctostaphylos pungens*, mientras que *Pinus chihuahuana*, *Quercus eduardii*, *Q. emoryi*, *Garrya wrightii*, *Perymenium* sp., *Yucca* sp., *Nolina durangensis*, *N. juncea* y *Agave parryi* son escasos. En cañadas y sitios con mayor humedad ambiental se encuentran *Q. oblongifolia*, *Ceanothus greggii*, *Purshia mexicana* y, de manera muy aislada, *Arbutus arizonica*, *Quercus rugosa*, *Q. sideroxyla* y *Comarostaphylis polifolia*; en sitios más secos prevalecen *Quercus chihuahuensis*, *Mimosa aculeaticarpa* var. *biuncifera*, *M. dysocarpa*, *Dalea bicolor* y *Verbesina chihuahuensis*. La cobertura aérea y frecuencia de las principales especies leñosas se presenta en el Cuadro 2.

Por lo menos dos elementos se conocen como endémicos a la Sierra de Coneto: *M. theresae* y *Megacorax gracielanus*, género y especie descubiertos durante el desarrollo de este trabajo. Este descubrimiento confirma la necesidad de mayor exploración botánica, y no se descarta la posibilidad de encontrar más elementos de interés en el área.

Fenología

Durante la época de lluvias (mayo-julio) la planta aumenta de volumen, alcanzando su mayor tamaño (hasta 2.6 cm de diámetro y 4.2 cm de altura) entre junio y agosto, período en el que se registran incrementos desde 0.3 hasta

CUADRO 1. Cobertura y frecuencia de *Mammillaria theresae* y su flora acompañante, roca, suelo y grava. Datos en orden de importancia de acuerdo a la cobertura.

Componente	Longitud de intercepción (m)	Cobertura Relativa (%)	Frecuencia	Frecuencia Relativa (%)
Roca	158.86	37.824	346	20.13
Grava	80.844	19.249	320	18.62
Selaginella schaffneri y *S. rupincola*	67.319	16.028	261	15.18
Suelo	42.643	10.153	283	16.46
Gramíneas	38.697	9.214	309	17.98
Piedra	9.86	2.348	40	2.33
Musgos	3.906	0.930	33	1.92
Herbáceas	3.233	0.770	31	1.80
Quercus depressipes	3.19	0.760	7	0.41
Agave parryi	3.185	0.758	12	0.70
Arctostaphylos pungens	2.39	0.569	4	0.23
Selaginella pilifera	1.78	0.424	17	0.99
Mimosa aculeaticarpa y *M. dysocarpa*	1.05	0.250	7	0.41
Otros arbustos	0.95	0.226	4	0.23
Polypodiaceae	0.635	0.151	10	0.58
Purshia mexicana	0.41	0.098	1	0.06
Sedum pringlei	0.336	0.080	7	0.41
Pinus cembroides	0.29	0.069	2	0.12
Mammillaria theresae	0.247	0.059	19	1.11
Megacorax gracielanus	0.105	0.025	1	0.06
Opuntia sp.	0.05	0.012	2	0.12
Mammillaria sp.	0.02	0.005	3	0.17
Total	420.00	100.00	1719	100.00

1.5 cm del diámetro original. Durante 2002, en julio se presentó una tendencia a la reducción del volumen. En la Figura 5 se muestra el cambio en diámetros de la mayoría de los individuos muestreados (promedio), y en la Figura 6 se presenta el cambio ocurrido en el individuo de mayor diámetro y en los de menor diámetro registrados; la línea truncada de la Figura 6 indica la desaparición, debido a la ampliación del camino, del individuo más grande. El diámetro de los individuos adultos varía entre 0.5 y 2.6 cm. Cuando la planta alcanza su mayor tamaño, los tubérculos del tallo se alargan, llegando a medir 0.2 a 0.5 cm, y se separan entre sí hasta 0.4 cm, y la planta toma un color morado-verdoso. En la estación seca (enero-abril), las plantas pierden volumen, contrayéndose hasta más de un 50% de su tamaño y permaneciendo enterradas en el suelo y fisuras de las rocas hasta el nuevo ciclo de lluvias, lo que dificulta su localización. En el área se encuentran pequeñas rocas en forma redondeada de aspecto muy similar al de *M. theresae*.

CUADRO 2. Cobertura aérea y frecuencia de los principales elementos leñosos de la vegetación donde ocurre *Mammillaria theresae*.

Especies	Longitud de intercepción (m)	Cobertura Relativa (%)	Frecuencia	Frecuencia relativa (%)
Pinus cembroides	14.69	47.76	5	15.63
Quercus depressipes	5.69	18.50	9	28.13
Arctostaphylos pungens	1.86	6.05	4	12.50
Mimosa acanthocarpa var. *biuncifera y M. dysocarpa*	4.7	15.28	5	15.63
Dalea bicolor	0.31	1.01	1	3.13
Perymenium sp.	0.46	1.50	3	9.38
Garrya sp.	0.36	1.17	1	3.13
Ceanothus gregii	0.2	0.65	1	3.13
Purshia mexicana	2.31	7.51	2	6.25
Verbesina sp.	0.18	0.59	1	3.13
Total	30.76	100.00	32	100.00

Durante 2002, *M. theresae* presentó dos períodos de floración, uno a mediados de mayo y otro a principios de julio. Con base en estudios en vivero, Kleine & Kluger (2002) reportan que la planta florece de manera intermitente desde las primeras semanas de mayo hasta mediados de julio, presentando dos o tres períodos de floración. La flor es de color violeta pálido a intenso, de 2.5 a 4.7 cm de largo (incluyendo el tubo de 0.8 a 2.5 cm) y hasta de 4.5 cm de diámetro, con 18 a 32 pétalos; las anteras son de color amarillo intenso. En un período de floración se desarrollan una a tres, raramente cuatro, flores por individuo. La flor dura de dos a tres días, abriendo por la mañana y cerrando por la tarde. Se observaron flores ramoneadas y separadas de la planta. El fruto es rojo, diminuto, de aproximadamente 2 mm de ancho. Las semillas permanecen retenidas en la planta por varios meses, protegidas entre los lóbulos del tallo y particularmente en la base de éste, en un engrosamiento formado por el tallo que se compacta en la época seca con la parte superior de la raíz.

Dispersión

La dispersión se lleva a cabo principalmente por arrastre, ya que el fruto y las semillas son movidos por el agua o el viento. Las semillas se establecen en las fisuras de las rocas o sobre el suelo somero. Adicionalmente, las plantas muertas o desenterradas por efecto de la erosión, son arrastradas por el agua o el viento y dispersan las semillas que aún permanecían adheridas entre los lóbulos del tallo y en el engrosamiento en la base de éste, dando origen a nuevas colonias. Las plántulas aparecen en el mes de agosto, tanto aisladas como alrededor de la planta madre. No se observaron indicios de dispersión por animales, aunque cabe la posibilidad de que ocurra.

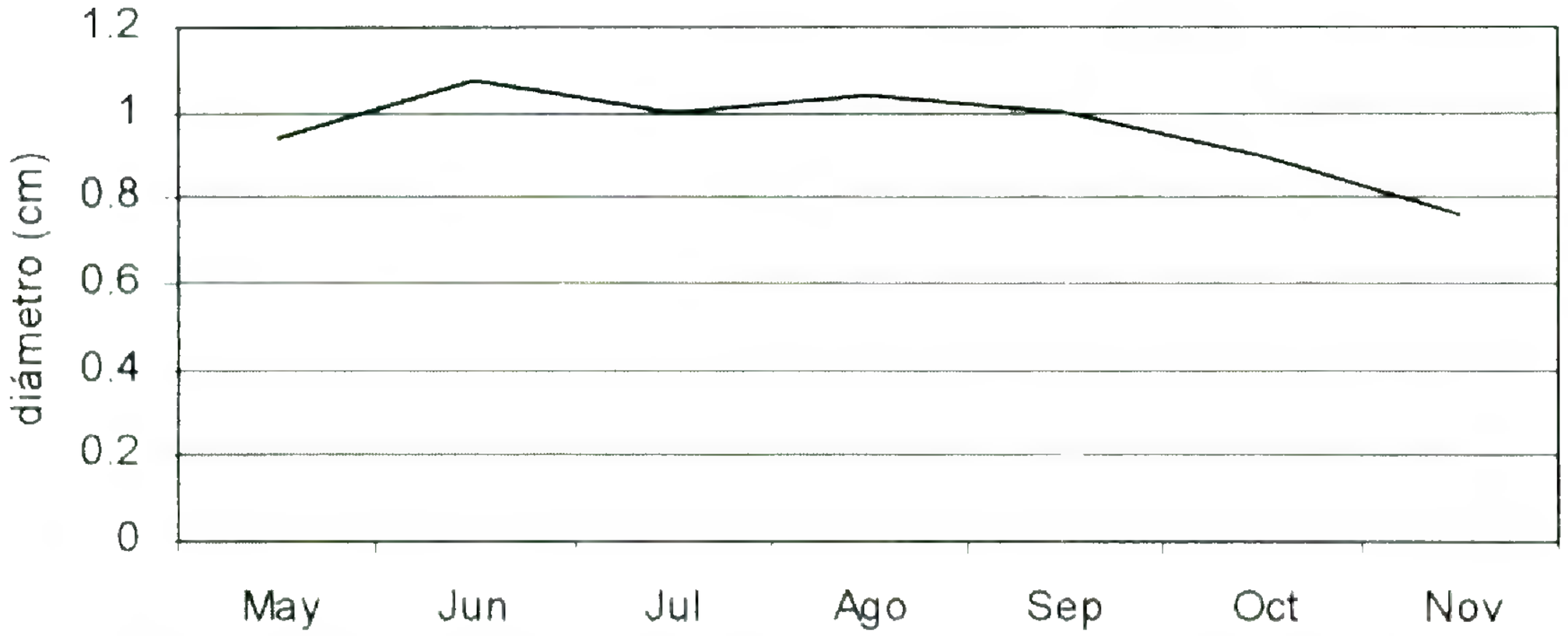


FIG. 5. Variación promedio en el diámetro de *Mammillaria theresae* durante la estación de crecimiento.

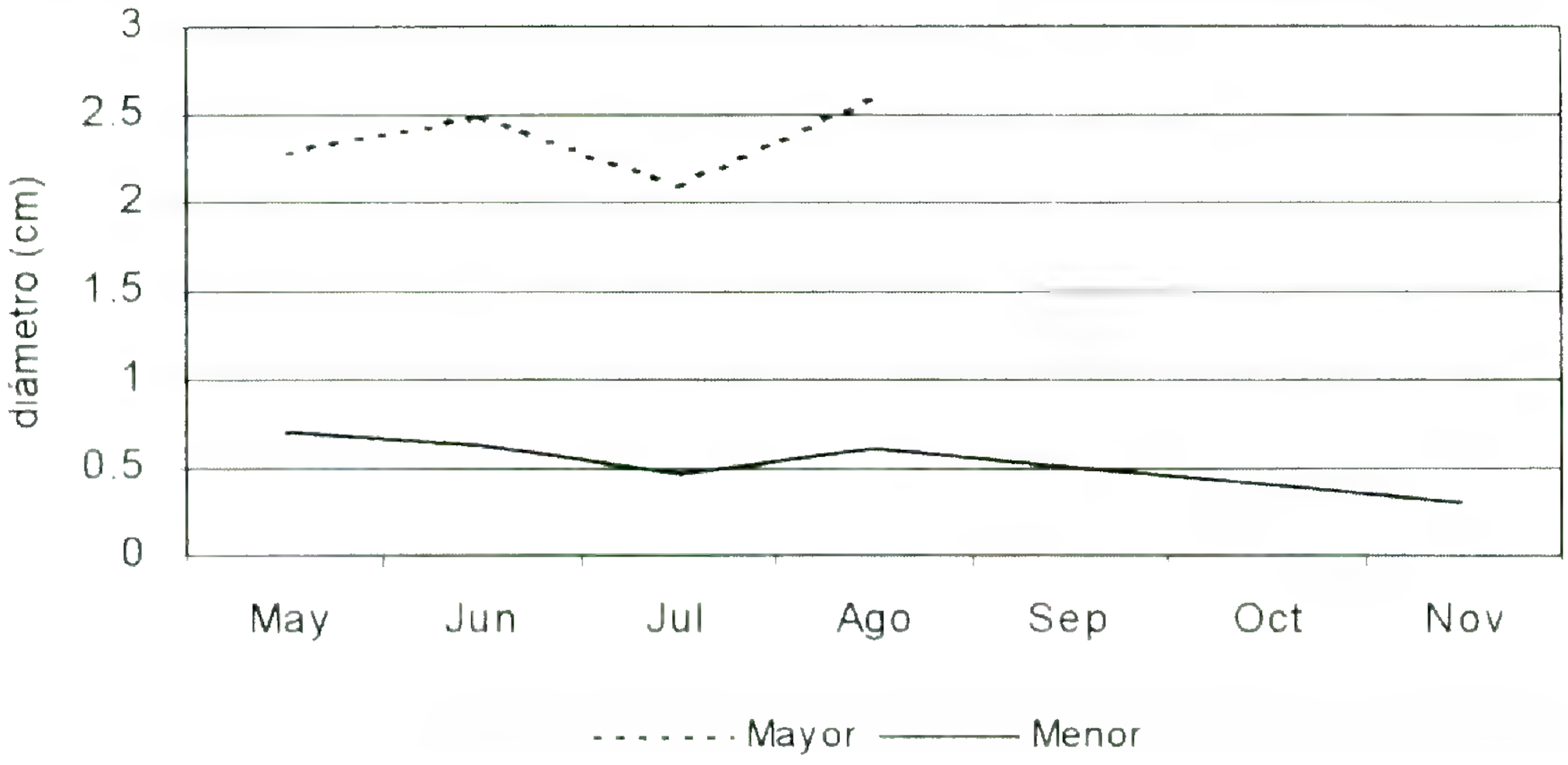


FIG. 6. Variación en el diámetro del mayor individuo de *Mammillaria theresae* registrado, y de los individuos más pequeños, durante la estación de crecimiento.

Estado de conservación

Mammillaria theresae está incluida en la Norma Oficial Mexicana (NOM-059-ECOL-2001) como especie amenazada. Hernández y Godínez (1994) y Hunt (1987), la reportan como especie amenazada, conocida únicamente de la localidad tipo, mientras que Vovides (1981), la cita como especie en peligro de extinción. Los criterios para definir "rareza" en grupos taxonómicos particulares son variables (Ceballos 2001). Se consideran especies raras aquellas que tienen distribuciones restringidas, poblaciones poco abundantes o combinaciones de ambos factores. Las especies de distribución restringida son más vulnerables a

la extinción como resultado de actividades antropogénicas que destruyen o modifican el ambiente, caso en el que se encuentra *M. theresae*. La Unión Mundial para la Naturaleza (IUCN) considera especies raras a las que tienen áreas de distribución menores de 50 000 km^2 y clasifican a *M. theresae* en la categoría de especies vulnerables. La especie no se incluye en el Apéndice I de la CITES.

Se han realizado estudios para conservar especies de cactáceas que se encuentran en alguna categoría de riesgo. Hernández y Sánchez (2000), reportan 384 especies que se encuentran en 19 colecciones de jardines botánicos en la República Mexicana, en los que se llevan a cabo acciones para conservar y reproducir especies en riesgo. No se tienen reportes de que *M. theresae* se encuentre jardines botánicos de México, a excepción probablemente del jardín botánico del Grupo Cante, en Guanajuato. La especie se ha reproducido con éxito en Europa en diversos jardines botánicos y en viveros para venta. Aunque en el Instituto Tecnológico Agropecuario No 1 de Durango se están reproduciendo las semillas con éxito, no existe un programa de dispersión de la especie en México.

Aplicando los criterios del Libro Rojo de Datos (IUCN 1980), *M. theresae* califica en la categoría de en peligro de extinción. El mismo resultado se obtiene al aplicar el método de evaluación del riesgo de extinción de especies que marca el Anexo Normativo I de la NOM-059-ECOL-2001. Por su distribución muy restringida (menos de 2 km^2), su población pequeña y el disturbio y la fragmentación de su hábitat debido a la ampliación del camino, *M. theresae* es evidentemente una especie en peligro. Por tanto, se requieren acciones inmediatas de protección que eviten su desaparición.

CONCLUSIONES

Mammillaria theresae presenta una distribución muy restringida, y hasta ahora se conoce únicamente del área conocida como Puerto de Coneto y sus alrededores. La búsqueda de *M. theresae* ha permitido el descubrimiento de un género y especie nuevos, lo que parece indicar que el área representa una zona de interés florístico que debe ser estudiada con más detenimiento.

De los diversos reportes en que se menciona a esta especie, la mayoría coinciden en que se encuentra en la categoría de amenazada. Sin embargo, el análisis de sus condiciones actuales (área de distribución muy pequeña, crecimiento lento y alteración y fragmentación en su hábitat) señala que se encuentra en peligro de extinción. Para que el desarrollo social y económico vayan a la par con la conservación de los ecosistemas, es necesario que las nuevas obras estén avaladas por un estudio de impacto ambiental previo. En el caso de la ampliación del camino que afecta a la población de *M. theresae*, de existir un estudio de impacto ambiental, no se consideró que el área representaba la única

localidad conocida de una especie, y no se aplicaron acciones que permitan mitigar el impacto en esa población. Es urgente el establecimiento de un programa para la protección de esta especie y de su hábitat.

AGRADECIMIENTOS

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TYPE LOCALITIES OF VASCULAR PLANTS FIRST DESCRIBED FROM OHIO

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Type localities are those places where biological specimens were obtained that subsequently were used as the basis for the scientific name and description of any organism when it was first described as new to science. Throughout the history of classical and descriptive biology, countless numbers of organisms, or taxa, have been named and described. Along with each new taxon, usually but not always, is recorded its original source location, or type locality. These type localities are deserving of permanent record, because they are the special places to which a biologist must return if he is to obtain living material from descendents of the original populations. A biologist may need to verify the identity and description of the taxon in the area where the original population occurred, obtain material for genetic and developmental studies, and/or acquire populational and life-history information. With the expansion of taxonomic studies into the broader realms of biosystematics and population analysis that has come into prominence within the past half century, much more importance is now accorded the type localities than in earlier times. These classic sites are significant biogeographical reference points at the international, national, and state levels. They should be spared from permanent destruction, such as the flooding of a river valley by construction of a dam on a stream or river, the building of a housing or industrial complex, the construction of a highway, or the tilling of the land for agricultural purposes. Type localities therefore may serve as criteria for evaluating areas or sites as potential nature sanctuaries, as discussed by Stuckey (1994).

Information on the type localities of plants first described from the United States is inadequately documented as a subject by itself. Although the information is recorded and scattered throughout the descriptive historical and botanical literature, it has not been brought together into accessible and usable data banks. Taxonomic monographs regularly include information on the type localities for names applied to the taxa discussed in those papers, but they deal only with small groups of species, and the organization is taxonomic rather than according to the geographic origin of the specimens. A project to record

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type localities for species within a genus was presented in a catalogue of type specimens for names in the large genus *Carex* (Cyperaceae) (Shetler et al. 1973). It included an index to the states, provinces, and countries from which the specimens were obtained. Lists of the type specimens deposited therein have been compiled for many herbaria, but these references list specimens according to the repositories rather than according to their geographic origin. "Botanical gazetteers" have been compiled for a few states, but do not deal specifically with type localities. At the state level, we are aware of published lists of type localities for only four states, viz. Illinois (Jones 1952), Iowa (Lammers 1985), New Mexico (Standley 1910), and West Virginia (Core 1936). A few smaller lists cover either a region or a specific county in the United States. Below are listed over 60 type localities for Ohio, from which a total of 197 vascular plants were first described from the state. Stuckey and Wentz (1974) have previously catalogued the type specimens from these localities that were deposited in the herbarium of The Ohio State University.

That the precise location of the original sources of many of these new taxa described from Ohio is not given is not surprising. Many of the taxa were named in the nineteenth century, when precision as to location was of little concern, since no *International Code of Botanical Nomenclature* existed and little emphasis was placed on the source location of new biological entities. In those days it was considered sufficient to record the location of a newly described plant from such broadly defined areas as the State of Ohio, the shore of Lake Erie, the Miami River valley, or the Ohio River. The last locality, of course, means from along the banks of the Ohio River or from its vicinity. The most notable example of this situation is the 112 or more taxa described between 1808 and 1840 from Ohio by Constantine Samuel Rafinesque, who listed the source localities as "Ohio," "Lake Erie," or "Ohio River." Rafinesque's 17 vascular plants named from the shore of Lake Erie[1] and nine noted as being from the Ohio River are included in the list below, although some of Rafinesque's plants may have been obtained on the Kentucky side of the river. With the exception of one name in current usage and two upon which currently used names are based, the many taxa described by Rafinesque merely as from "Ohio" are not listed here, but they can be determined from *Index Rafinesquianum* (Merrill 1949). André Michaux's taxa described from the Ohio River are also listed, but the exact locations along the river where these plants were obtained are not known. Michaux is known to have conducted some botanical exploration near the Ohio River in the vicinity

[1]Some or perhaps all of the plants Rafinesque described from the shore of Lake Erie may have been observed at Sandusky, Erie County, where he waited three days in late May 1826 for a steamboat from Detroit that took him to Buffalo. However, during the route to Buffalo he did stop briefly at such places as Cleveland and Fairport (Rafinesque 1826, pp. 6–7; 1836a, pp. 80–81). He also noted later that the shore of Lake Erie near Sandusky represented a locality of "great botanical interest" that afforded him new species of plants (Rafinesque 1836b, pp. 28–29).

of Louisville, Kentucky, and in what is now southern Illinois, as well as near the present site of Portsmouth, Ohio. Some specimens recorded by Michaux as having been obtained from the "Ohio River" or its banks are, therefore, likely from localities outside present-day Ohio.

In other situations only the nearest town was mentioned, with no specific sites or habitats given for the plant. Some sites are sufficiently well described so that their locations can be determined today. Among the best-known type localities in Ohio from which vascular plants have been described are Beaver Pond in Adams County, Cedar Bog (Cedar Swamp) in Champaign County, Cedar Point and other locations near Sandusky in Erie County, the limestone cliffs along the Scioto River north of Columbus and other sites in Franklin County, Hoffman's Prairie (Wright Brothers Prairie) east of Dayton in Greene County, Rocky Fork Creek in Highland County, Ofer Hollow in Jackson County, and Cranberry Island in Buckeye Lake in Licking County. Significant type localities that have disappeared through agricultural or industrial development include the Oxford Prairie in Erie County, the Darby Plains in Madison County, and Van Cleve's Prairie near Dayton in Montgomery County.

The general locations of the type localities listed below are shown on a map of Ohio (Fig. 1), and two additional maps show portions of the state where many type localities are concentrated in small areas (Figs. 2, 3). The localities are concentrated mostly in the Miami valley in southwestern Ohio, in Franklin and adjacent counties in central Ohio, and near Lake Erie in northern Ohio. These locations reflect the pioneer botanical exploration in Ohio, first in the Miami River valley in the early 1800s, in central Ohio mostly in the mid 1800s, and in northern Ohio primarily about 1900 and later. The more unusual habitat types represented are fens, wet prairies, and limestone cliffs. These habitats are not well represented in the states to the east of Ohio where most of the descriptive botany had been written before the early 1800s. It is understandable, therefore, that plants characteristic of these habitats that had not previously been named and described were first described from places in Ohio.

Unlike the other state lists mentioned above, which were arranged alphabetically by taxon, this list for Ohio is organized by locality, beginning with the largest unit, Ohio, followed by sections of the state including the shore of Lake Erie, the Miami River valley, and the Ohio River valley, and then alphabetically by county. Those taxa with more specific locality data are listed under each county. If two or more localities in Ohio were cited when a taxon was first described, as for example with *Valeriana ciliata* Torr. & A.Gray, all such localities are listed. All of the names based on specimens from the same type locality are listed under that locality, in alphabetical order. An index to names of taxa, by genus only, begins on page 1691.

Double asterisks denote plant names that are currently accepted as the correct names for the respective taxa. Single asterisks denote names that are no

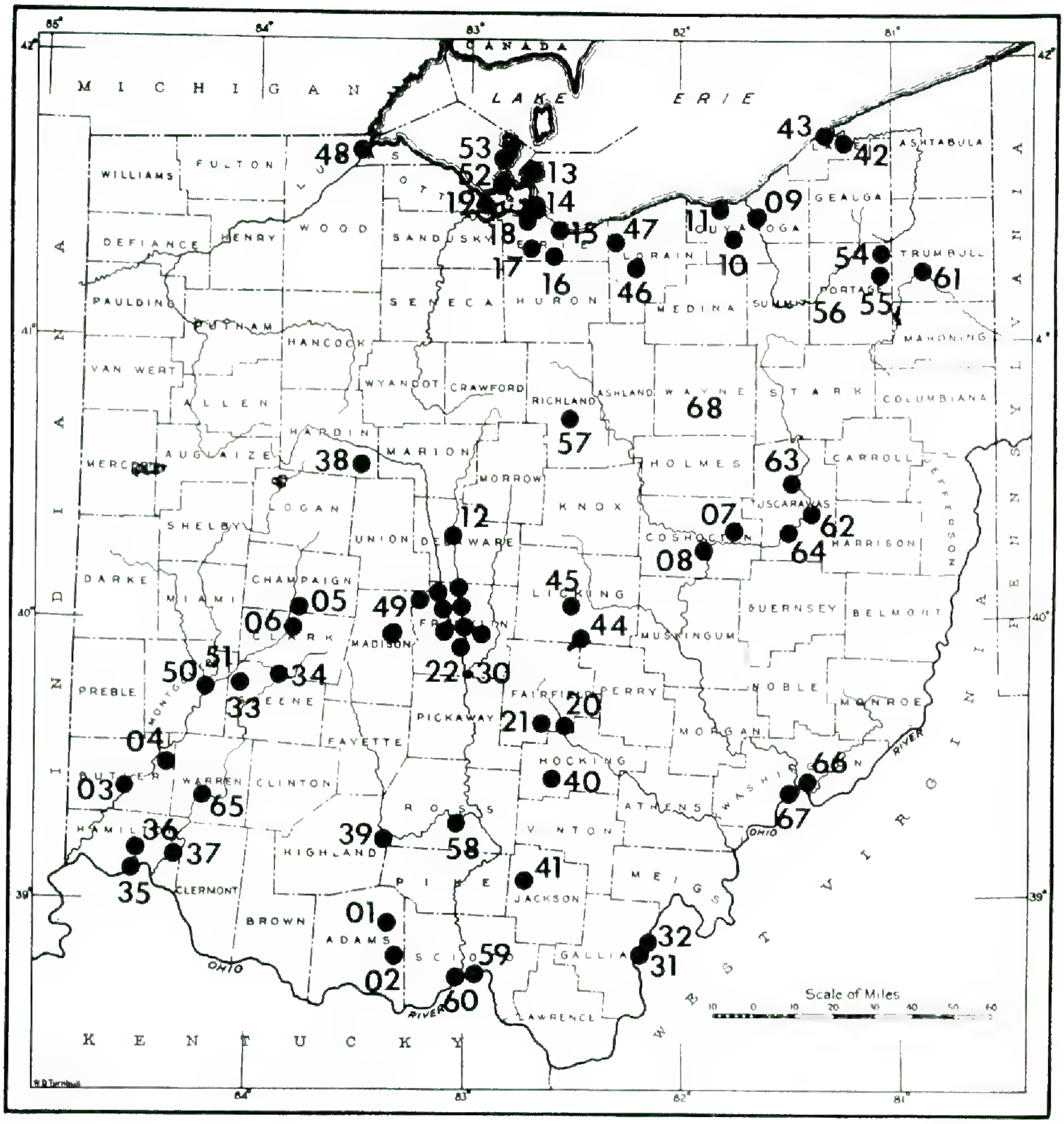


FIG. 1. Map of Ohio showing by numbered dot the type localities of vascular plants first described from that state in the United States of America. Those numbers without dots indicate that the type location in that county is not known.

longer in use, or at least are not accepted in the standard references consulted in the present study, but which have been superseded by currently accepted names based directly upon them. Single asterisks are also used for the names of taxa originally described as species that are now considered to be interspecific hybrids. In these cases, the present-day name generally includes the original epithet, meaning the adjectival component of the name in a nomenclatural combination that was published later. The type localities remain the same. When the name based on a specimen or specimens obtained in Ohio is no longer in use for a taxon, the currently accepted name is given in brackets when possible. Currently accepted names and taxonomic synonymy have been deter-

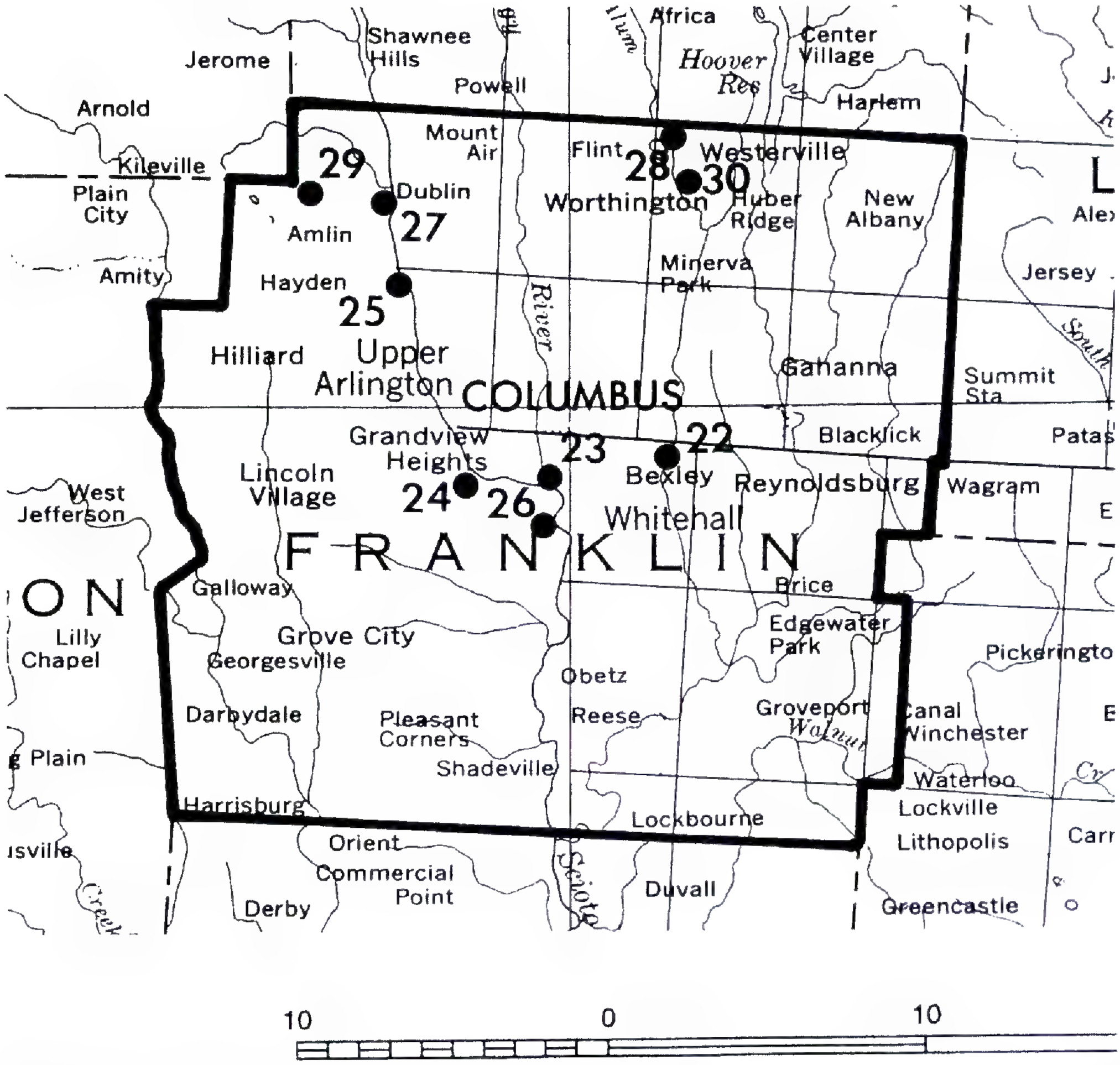


FIG. 2. Map of Franklin County, Ohio, showing by numbered dot the type localities of vascular plants first described from that county in Ohio.

mined primarily from Kartesz (1994), Kartesz and Meacham (1999), and those volumes of the *Flora of North America North of Mexico* that had been published at the time of this writing. For some old names not listed even in synonymy in these works, the modern equivalents have been determined from older floras, such as those by Britton and Brown (1913), Fernald (1950), and Gleason (1952), and from monographs, notably those by Boivin (1944) on *Thalictrum*, Davis et al. (1967–1970) on *Rubus*, Fernald (1905) on *Eriophorum*, Heiser et al. (1969) on *Helianthus*, Mackenzie (1931–1935) on *Carex*, and Palmer (1956, 1961) on *Crataegus*. When no current status or taxonomic equivalent is given for a name published at the rank of variety, it may be inferred that varieties are now gener-

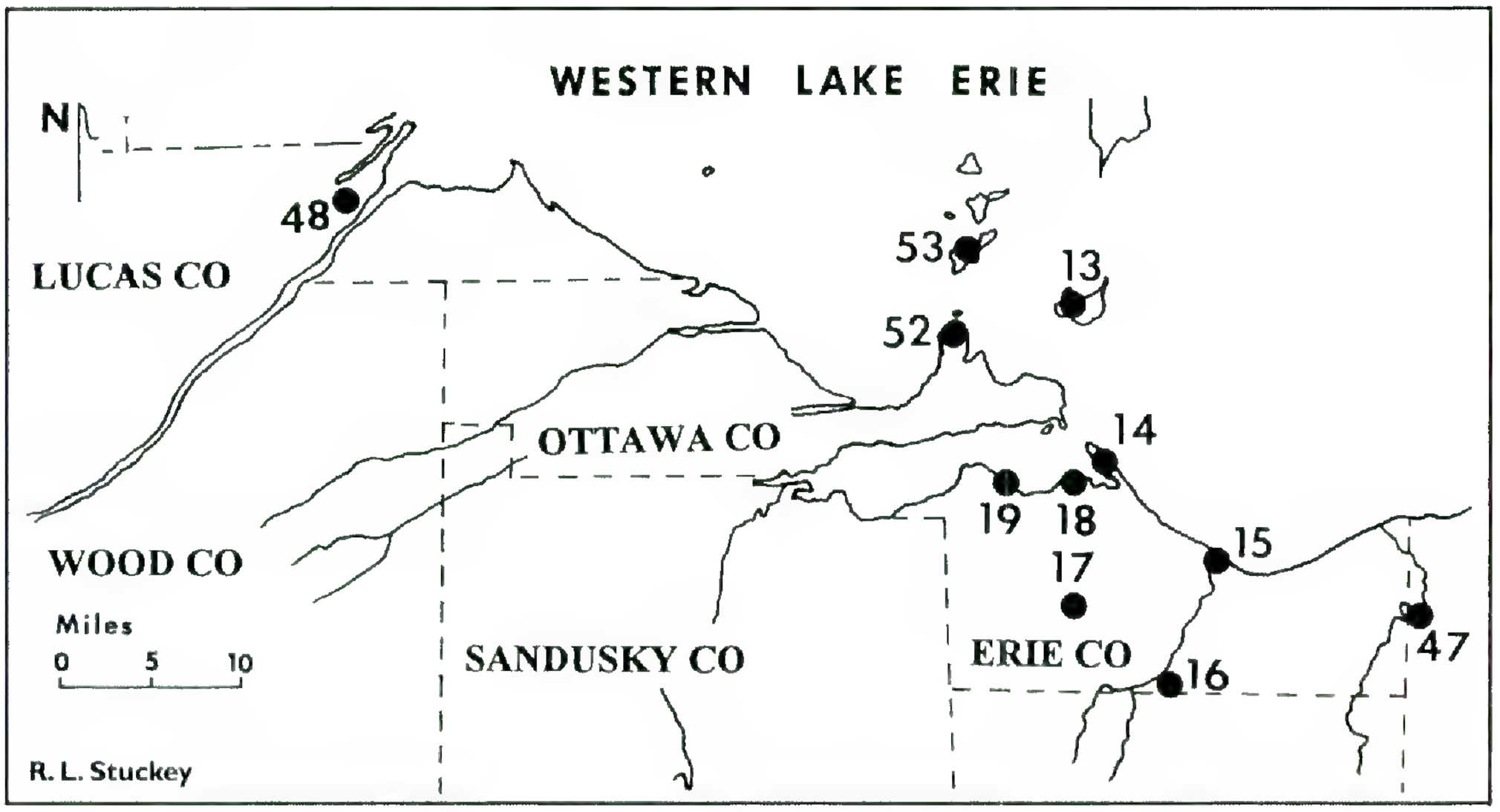


FIG. 3. Map of the Ohio counties along the shoreline of Western Lake Erie showing by numbered dot the type localities of vascular plants first described from this region of Ohio.

ally not recognized within that species. In these cases, when a synonym is given for the species, it should not be assumed that the minor variant described as a variety is equivalent to the entire species. Current status is not indicated for names published at the rank of form (Latin *forma*, abbreviation "f."), because names at this rank are not usually included in modern floras. In most cases, the original epithet applied to the form, transferred if necessary to the currently accepted name for the species, which is indicated here, would be correct for anyone wishing to use names for these individual variations.

In some cases it has not been possible to equate an older name with any currently accepted taxonomic equivalent. When the original description is deficient in detail and the original specimens no longer exist, it may not be certain to which currently recognized taxon an old name, based on plants occurring in Ohio, was applied, although taxonomic research continues to resolve some of these long-persistent questions. This situation is an especially frequent problem with plants named by Rafinesque. The best single source for their interpretation is Merrill's (1949) *Index Rafinesquianum*. Other publications that are especially significant with regard to plants originally described from Ohio specimens include the first author's studies of the plants named and described by Daniel Drake (Stuckey 1969) and Thomas Nuttall (Stuckey 1966, 1967), and his studies of the plants described by C.S. Kunth and E.G. von Steudel from specimens obtained in the Miami River valley by Joseph Frank (Stuckey 1974).

THE PLANTS AND THEIR TYPE LOCALITIES

OHIO

****Acalypha rhomboidea** Raf., New Fl. 1:45. 1836 [sometimes included in *Acalypha virginica* L., as var. *rhomboidea* (Raf.) Cooperr.].

Aesculus ohioensis Riddell, W.J. Med. Phys. Sci. 8:360. 1835. Reprint p. 34. 1835 [*Aesculus glabra* Willd.].

Cakile americana Nutt., Gen. N. Amer. Pl. 2:62. 1818 [*Cakile edentula* (Bigelow) Hook. subsp. *edentula*].

Carex laxiflora Lam. var. *latifolia* Boott, Ill. Carex p. 38, pl. 93. 1858 [*Carex albursina* E.Sheld.].

Carex alata Torr. var. *ferruginea* Fernald, Proc. Amer. Acad. Arts 37:477, pl. 2. 1902 [*Carex suberecta* (Olney) Britton].

****Carex comosa** Boott, Trans. Linn. Soc. London 20:117. 1846.

Carex davisii Schwein. & Torr. f. *glabrescens* Kük. in Engl., Pflanzenr. 4(20):588. 1909.

Carex foenea Willd. var. β Boott, Ill. Carex p. 118, pl. 376. 1862 [*Carex suberecta* (Olney) Britton].

Carex foenea Willd. var. *ferruginea* A.Gray, Manual, ed. 5, p. 580. 1867 [*Carex suberecta* (Olney) Britton].

Carex laxiflora Lam. var. *blanda* (Dewey) Boott subvar. *gracillima* Boott, Ill. Carex p. 38, pl. 91, fig. 2. 1858 [*Carex gracilescens* Steud.].

***Carex monile** Tuck., Enum. Meth. Caric. p. 20. 1843 [*Carex vesicaria* L. var. *monile* (Tuck.) Fernald].

***Carex tenera** Dewey var. *suberecta* Olney, Carices Bor.-Amer. 3:1871 [*Carex suberecta* (Olney) Britton].

Crataegus ridgwayi Sarg., J. Arnold Arbor. 6:2. 1925 [*Crataegus mollis* (Torr. & A.Gray) Scheele].

***Cyanotris scilloides** Raf., Amer. Monthly Mag. & Crit. Rev. 3:356. 1818 [*Camassia sciloides* (Raf.) Cory].

****Eleocharis erythropoda** Steud., Syn. Pl. Glumac. 2:76. 1854 [long known as *Eleocharis calva* Torr., an invalid name].

Eriophorum gracile W.D.J.Koch ex Roth [var.] β *paucinervium* Engelm., Amer. J. Sci. Arts 46:103. 1844 [*Eriophorum tenellum* Nutt.].

***Eriophorum latifolium** Hoppe [var.] β *viridicarinatum* Engelm., Amer. J. Sci. Arts 46:103. 1844, "*viridi-carinatum*" [*Eriophorum viridicarinatum* (Engelm.) Fernald].

****Euphorbia commutata** Engelm. ex A.Gray, Manual, ed. 2., p. 389. 1856.

Fimbristylis frankii Steud., Syn. Pl. Glumac. 2:111. 1855 [*Fimbristylis autumnalis* (L.) Roem. & Schult.].

***Hedysarum pauciflorum** Nutt., Gen. N. Amer. Pl. 2:109. 1818 [*Desmodium pauciflorum* (Nutt.) DC.].

****Helianthus microcephalus** Torr. & A.Gray, Fl. N. Amer. 2:329. 1842.

Hydrophyllum hispidum Riddell, W.J. Med. Phys. Sci. 8:516. 1835. Reprint p. 84. 1835 [*Hydrophyllum macrophyllum* Nutt.].

****Juncus brachycarpus** Engelm., Trans. Acad. Sci. St. Louis 2:467. 1868.

***Juncus canadensis** J.Gay var. *brachycephalus* Engelm., Trans. Acad. Sci. St. Louis 2:474. 1868 [*Juncus brachycephalus* (Engelm.) Buchenau].

Lysimachia revoluta Nutt., Gen. N. Amer. Pl. 1:122. 1818 [*Lysimachia quadriflora* Sims].

****Poa sylvestris** A.Gray, Manual, ed. 1, p. 596. 1848.

Scutellaria ambigua Nutt., Gen. N. Amer. Pl. 2:37. 1818 [*Scutellaria nervosa* Pursh].

Scutellaria versicolor Nutt., Gen. N. Amer. Pl. 2:38. 1818 [*Scutellaria ovata* Hill subsp. *ovata*].

****Stachys cordata** Riddell, W.J. Med. Phys. Sci. 9:579. 1836. Reprint p. 15. 1836 [often called *Stachys nuttallii* Shuttlew. ex Benth. in recent literature, but no valid reason exists to reject the name *S. cordata* Riddell].

***Tetraneuris herbacea** Greene, Pittonia 3:368. 1898 [now usually treated as *Hymenoxys herbacea* (Greene) Cusick, but sometimes retained in *Tetraneuris*].

****Tradescantia ohioensis** Raf., Précis Découv. Somiol. p. 45. 1814; see also New Fl. N. Amer. 2:84. 1836 [1837].

Vernonia altissima Nutt., Gen. N. Amer. Pl. 2:134. 1818 [*Vernonia gigantea* (Walter) Trel. subsp. *gigantea*].

LAKE ERIE, SHORE OF (Probably at Sandusky, Erie County)

Aesculus muricata Raf., Alsogr. Amer. p. 68. 1838 [*Aesculus glabra* Willd.].

Asclepias dasypus Raf., Atlantic J. 1:152. 1832 [*Asclepias purpurascens* L.].

Asclepias rotundifolia Raf., Atlantic J. 1:152. 1832, not Mill. 1768 [*Asclepias amplexicaulis* J.E.Sm.].

Caprifolium dentatum Raf., Atlantic J. 1:151. 1832 [*Lonicera dioica* L.].

Cornus punctata Raf., Alsogr. Amer. p. 62. 1838 [*Cornus alternifolia* L.].

Cornus suffruticosa Raf., Atlantic J. 1:151. 1832; Alsogr. Amer. p. 61. 1838.

Fragaria elatior Raf., Atlantic J. 1:152. 1832, not Ehrh. 1792 nor Wight & Arn. 1834.

Fragaria serotina Raf., Atlantic J. 1:152. 1832.

Lathyrus incurvus Raf., Atlantic J. 1:151. 1832, not Roth 1787 nor Willd. 1802 nor Rchb. 1832.

Lobelia falcata Raf., New Fl. 2:18. 1836 [1837] [*Lobelia kalmii* L.].

Lonicera eriensis Raf., New Fl. 3:18-19. 1836 [1838] [?*Lonicera hirsuta* Eaton].

Lysimachia sessilifolia Raf., Atlantic J. 1:151. 1832 [*Lysimachia quadriflora* Sims].

Mentha traxigona Raf., Autik. Bot. p. 114. 1840.

Samolus petiolatus Raf., Herb. Raf. p. 41. 1833 [*Samolus valerandi* L. subsp. *paviflorus* (Raf.) Hultén].

Trillium brevipetalum Raf., Med. Fl. 2:100. 1830; Autik. Bot. p. 134. 1840 [*Trillium flexipes* Raf.].

Trillium rotundifolium Raf., Med. Fl. 2:97. 1830 [*Trillium erectum* L.].

Viola eriocarpa Raf., Atlantic J. 1:152. 1832 [nomenclaturally distinct from *Viola eriocarpa* Schwein. (1822), although probably taxonomically equivalent].

MIAMI VALLEY; MIAMI COUNTRY

**Ampelopsis quinquefolia* Michx. var. *vitacea* Knerr, Bot. Gaz. 18:70. 1893 [*Parthenocissus vitacea* (Knerr) Hitchc.].

Convolvulus micranthus Riddell, W.J. Med. Phys. Sci. 8:502. 1835. Reprint p. 70. 1835, not Roem. & Schult. 1819 nor Willd. ex Spreng. 1824 [*Ipomoea lacunosa* L.].

Carex flaccidula Steud., Syn. Pl. Glumac. 2:199. 1855 [*Carex rosea* Schkuhr ex Willd.].

***Carex gracilescens* Steud., Syn. Pl. Glumac. 2:226. 1855. 1849.

Carex steudelii Kunth, Enum. Pl. 2:480. 1837 [*Carex jamesii* Schwein.].

Eragrostis cognata Steud., Syn. Pl. Glumac. 1:273. 1854 [*Eragrostis pectinacea* (Michx.) Nees ex Steud.].

***Eragrostis frankii* C.A.Mey. ex Steud., Syn. Pl. Glumac. 1:273. 1854.

Eragrostis unionis Steud., Syn. Pl. Glumac. 1:273. 1854 [*Eragrostis pectinacea* (Michx.) Nees ex Steud.].

Valerianella triquetra Hochst. & Steud. ex Shuttlew., Flora 20:211. 1837 [*Valerianella chenopodiifolia* (Pursh) DC.].

OHIO RIVER

Asplenium angustifolium Michx., Fl. Bor.-Amer. 2:265. 1803 [*Diplazium pycnocarpon* (Spreng.) M.Broun].

Discovium gracile Raf., J. Phys. Chim. Hist. Nat. Arts 89:96. 1819 [?*Lesquerella globosa* (Desv.) S.Watson].

Eupatorium longipes Raf., Atlantic J. 1:17. 1832.

Eupatorium pectinatum Raf., Atlantic J. 1:17. 1832, not Wall. 1831 nor Small 1903.

Euphorbia thymifolia Michx., Fl. Bor.-Amer. 2:212. 1803, not L. 1753 [*Chamaesyce maculata* (L.) Small; sometimes retained in *Euphorbia*, as *E. maculata* L.].

Hibiscus hastatus Michx., Fl. Bor.-Amer. 2:45. 1803, not L.f. 1781 nor Cav. 1787 [*Hibiscus laevis* All.].

Ilysanthes riparia Raf., Ann. Nat. 1:13 1820 [*Lindernia dubia* (L.) Pennell var. *dubia*].

Lithospermum angustifolium Michx., Fl. Bor.-Amer. 1:130. 1803, not Forssk. 1775 nor Sessé & Moç. 1893 [*Lithospermum incisum* Lehm.].

Planera gmelinii Michx., Fl. Bor.-Amer. 2:248. 1803, "*gmelini*" [*Planera aquatica* (Walter) J.F.Gmel.].

Podalyria coerulea Michx., Fl. Bor.-Amer. 1:264. 1803 [*Baptisia australis* (L.) R.Br. ex W.T.Aiton var. *australis*].

***Polygonum amphibium* L. [var.] β *emersum* Michx., Fl. Bor.-Amer. 1:240. 1803.

Potamogeton natans L. [var.] β Michx., Fl. Bor.-Amer. 1:101. 1803 [*Potamogeton epihydrus* Raf.].

***Potentilla paradoxa* Nutt. in Torr. & A.Gray, Fl. N. Amer. 1:437. 1840, not Schur ex Nyman 1878.

Scutellaria radicata Raf., Atlantic J. 1:16. 1832.

***Spermacoce glabra* Michx., Fl. Bor. Amer. 1:82. 1803, not Roxb. 1820 nor Sessé & Moç. 1888.

Tilia fulva Raf., Alsogr. Amer. 45. 1838 [*Tilia americana* L.].

Vitis odoratissima Donn var. *atropurpurea* Raf., Med. Fl. 2:132. 1830.

****Vitis riparia** Michx., Fl. Bor.-Amer. 2:231. 1803.

ADAMS COUNTY

01. Beaver Pond: ****Asplenium ×inexpectatus** E.L.Braun ex C.V.Morton, Amer. Fern J. 46:152. "1956" [1957]. [= *Asplenium cryptolepis* Fernald × *A. rhizophyllum* (L.) Link; earlier binomial ×*Asplenosorus inexpectatus* E.L.Braun ex Friesner, Butler Univ. Bot. Stud. 4:154. 1940 was not validly published].

02. Prairie, north part of Jefferson Township, southeast of Scrub Ridge, 2 1/2 miles north of Ohio Route 348: ****Silphium terebinthinaceum** Jacq. var. *lucy-brauniae* Steyerm., Rhodora 53:133–135. 1951.

BUTLER COUNTY

03. Old prairie near Hamilton: *Amaranthus altissimus* Riddell, W.J. Med. Phys. Sci. 8:367. 1835. Reprint p. 41. 1835 [*Amaranthus tuberculatus* (Moq.) J.D.Sauer].

04. Small prairie half a mile south of Middletown: *Euphorbia herronii* Riddell, W.J. Med. Phys. Sci. 8:58. 1835. Reprint p. 32. 1835 [*Euphorbia dentata* Michx.].

CHAMPAIGN COUNTY

05. Cedar Swamp [now Cedar Bog], Urbana: ***Valeriana ciliata** Torr. & A.Gray, Fl. N. Amer. 2:49. 1841 [*Valeriana edulis* Nutt. ex Torr. & A.Gray var. *ciliata* (Torr. & A.Gray) Cronquist].

CLARK COUNTY

06. Near Springfield: ***Valeriana ciliata** Torr. & A.Gray, Fl. N. Amer. 2:49. 1841 [*Valeriana edulis* Nutt. ex Torr. & A.Gray var. *ciliata* Cronquist].

COSHOCTON COUNTY

07. North Appalachian Experimental Watershed, near Fresno, Chili, and Canal Lewisville:

Aralia spinosa L. f. *subinermis* Moldenke, Castanea 9:54. 1944.

Daucus carota L. f. *fischeri* Moldenke, Castanea 9:55. 1944.

Daucus carota L. f. *goodmanii* Moldenke, Castanea 9:55. 1944, "*goodmani*."

Lobelia inflata L. f. *albiflora* Moldenke, Castanea 9:65. 1944.

Lycopodium flabelliforme (Fernald) Blanch. f. *clutei* Moldenke, Castanea 9:32. 1944. [*Diphasiastrum digitatum* (A.Braun) Holub].

Morus alba L. f. *nigrobacca* Moldenke, Castanea 9:51. 1944.

Plantago rugelii Decne. f. *fasciculata* Moldenke, Castanea 9:65. 1944.

Tovara virginiana (L.) Raf. f. *rubra* Moldenke, Boissiera 7:4. 1943; see also Castanea 9:40. 1944 [*Polygonum virginiana* L.]. Although one might infer otherwise from Moldenke's paper in Castanea, this and the following two names were validly published in Boissiera.

Tracaulon sagittatum (L.) Small f. *subalbidum* Moldenke, Castanea 9:41. 1944 [*Polygonum sagittatum* L.].

Trifolium pratense L. f. *lilacinum* Moldenke, Boissiera 7:4–5. 1943; see also Castanea 9:49. 1944.

Vernonia altissima Nutt. f. *alba* Moldenke, Boissiera 7:5. 1943; see also Castanea 9:64. 1944 [*Vernonia gigantea* (Walter) Trel. subsp. *gigantea*].

08. Roscoe: *Stachys glabra* Riddell, W.J. Med. Phys. Sci. 9:580. 1836. Reprint p. 16. 1836 [*Stachys tenuifolia* Willd.].

CUYAHOGA COUNTY

09. Cuyahoga: *Hieracium watsonianum* Gand., Bull. Soc. Bot. France 65:49. 1918.

10. Parma: *Hieracium ohioense* Gand., Bull. Soc. Bot. France 65:48. 1918.

11. Rocky River, deep gorge about one-fourth mile from Lake Erie: *Cerastium arvense* L. var. *webbii* Jennings, Ohio Naturalist 9:441. 1909; see also Ohio Naturalist 10:136. 1910 [*Cerastium arvense* L. subsp. *velutinum* (Raf.) Ugbor. var. *velutinum*.]

DELAWARE COUNTY

12. Delaware: *Crataegus ellipticifolia* Sarg., J. Arnold Arbor. 3:194. 1922 [*Crataegus compacta* Sarg.].

ERIE COUNTY

13. Kelleys Island, bottom of deep northwest quarry by glacial grooves, N portion of Kelleys Island, Lake Erie: ****Juncus ×stuckeyi** M.Reinking, Brittonia 33:175. 1976 [= *Juncus alpinoarticulatus* Chaix × *J. torreyi* Coville].

14. Cedar Point: ***Helianthus luxurians** E.Watson, Pap. Michigan Acad. Sci. 9:464. 1929 [*Helianthus ×luxurians* E.Watson; pro sp.; = *H. giganteus* L. × *H. grosseserratus* M.Martens].

15. Huron River at mouth: *Phalangium esculentum* Nutt., Gen. N. Amer. Pl. 1:219. 1818 [*Camassia scilloides* (Raf.) Cory].

16. Milan: *Crataegus propinqua* Ashe, J. Elisha Mitchell Sci. Soc. 20:53–54. 1904 [*Crataegus iracunda* Beadle].

17. Oxford Prairie: *Solidago moseleyi* Fernald, Rhodora 10:93. 1908 [*Euthamia gymnospermoides* Greene; often included in *Solidago*, as *S. gymnospermoides* (Greene) Fernald].

Thalictrum moseleyi Greene, Amer. Midl. Naturalist 2:294. 1912 [*Thalictrum dasycarpum* Fischer & Avé-Lall.].

18. Sandusky: *Crataegus marcida* Ashe, J. Elisha Mitchell Sci. Soc. 20:53. 1904 [*Crataegus iracunda* Beadle].

Crataegus tenera Ashe, J. Elisha Mitchell Sci. Soc. 20:52–53. 1904 [*Crataegus macrosperma* Ashe].

19. Sandusky Bay: *Vicia douglassii* Torr., Amer. J. Sci. 4:66. 1822 [?*Vicia cracca* L.].

FAIRFIELD COUNTY

20. Sugar Grove: *Crataegus polybracteata* Ashe, J. Elisha Mitchell Sci. Soc. 16:79. 1899; see also E.J. Palmer, J. Arnold Arbor. 6:57. 1925 [*Crataegus intricata* Lange].

21. Clearport; T.12N, R.19W, sec. 10, 1.5 miles east of Clearport on the south side of County Highway 69, east of the covered bridge over Clear Creek: ***Cystopteris ×wagneri* R.C. Moran, Castanea 48:224. 1983 [– *Cystopteris tennesseensis* Shaver × *C. tenuis* (Michx.) Desv.].

FRANKLIN COUNTY

22. Bexley: *Triphora trianthophora* (Sw.) Rydb. var. *schaffneri* Camp, Rhodora 42:55. 1940.

23. Columbus: ***Asclepias sullivantii* Engelm. ex A.Gray, Manual, ed. 1, 366. 1848.

Aster laxifolius Nees [var.] β *laetiflorus* Torr. & A.Gray, Fl. N. Amer. 2:138. 1841 [*Aster borealis* (Torr. & A.Gray) Prov.; sometimes segregated from *Aster* as *Symphyotrichum boreale* Torr. & A.Gray) A.Löve & D.Löve].

***Carex conjuncta* Boott, Ill. Carex 3:122, pl. 392. 1862.

**Carex sullivantii* Boott in A.Gray, Amer. J. Sci. 42:29. 1842 [*Carex ×sullivantii* Boott, pro sp.; = *Carex hirtifolia* Mack. × *C. gracillima* Schwein.].

Crataegus ohioensis Sarg., J. Arnold Arbor. 3:183. 1922 [*Crataegus arborea* Beadle].

Fedia patellaria Sull. ex A.Gray, Manual, ed. 1, 183. 1848 [*Valerianella umbilicata* (Sull.) Alph. Wood].

**Fedia umbilicata* Sull., Amer. J. Sci. 42:50. 1842 [*Valerianella umbilicata* (Sull.) Alph.Wood].

**Helianthus kellermanii* Britton, Man. Fl. N. States p. 994. 1901, "*kellermani*"; see also W.A. Kellerman, Ohio Naturalist 2:179–181. 1902 [*Helianthus ×kellermanii* Britton, pro sp.; = *Helianthus salicifolius* A.Dietr. × *H. grosseserratus* M.Martens].

**Rudbeckia sullivantii* C.L.Boynton & Beadle, Biltmore Bot. Stud. 1:15. 1901 [*Rudbeckia fulgida* Aiton var. *sullivantii* (C.L.Boynton & Beadle) Cronquist].

24. Columbus, cat-tail swamp, three miles west: **Coreopsis discoidea* Torr. & A.Gray, Fl. N. Amer. 2:339. 1842 [*Bidens discoidea* (Torr. & A.Gray) Britton].

25. Columbus, rocky limestone banks of the Scioto River: ***Arabis patens* Sull., Amer. J. Sci. 42:49. 1842, not Royle ex Hook.f. & Thomson 1861.

**Lonicera glaucescens* Rydb. var. *dasygyna* Rehder, Annual Rep. Missouri Bot. Gard. 14:181. 1903 [*Lonicera dioica* L. var. *dasygyna* (Rehder) Gleason].

Lonicera flava Sims var. β Torr. & A.Gray, Fl. N. Amer. 2:6. 1841 [*Lonicera reticulata* Raf.].

Lonicera parviflora Lam. [var.] β? [sic] *sullivantii* Alph.Wood, Class-book Bot., ed. 2, p. 298. 1847. Based on the Ohio component of *Lonicera parviflora* var. β Hook. sensu Torr. & A.Gray, Fl. N. Amer. 2:7. 1841, but nomenclaturally distinct; type locality determined from Torrey and Gray [*Lonicera reticulata* Raf.].

26. Columbus, two miles south: ***Solidago ohioensis* Riddell, W.J. Med. Phys. Sci. 8:497. 1835. Reprint p. 57. 1835 [sometimes segregated from *Solidago* as *Oligoneuron ohioense* (Riddell) G.N.Jones].

27. Dublin, calcareous ravine and steep declivity on the Scioto River: *Prenanthes proteophylla* Riddell, W.J. Med. Phys. Sci. 8:490. 1835. Reprint p. 50. 1835 [*Prenanthes alba* L.].

***Trillium nivale* Riddell, W.J. Med. Phys. Sci. 8:525. 1835. Reprint p. 93. 1835.

28. Between Flint and Glenmary: *Crataegus franklinensis* Sarg., J. Arnold Arbor. 4:100. 1923 [*Crataegus dissona* Sarg.].

29. Scott's Plains, 12 miles east from Worthington: ****Solidago riddellii* Frank in Riddell, W.J. Med. Phys. Sci. 8:497. 1835. Reprint p. 57. 1835 [sometimes segregated from *Solidago* as *Oligoneuron riddellii* (Frank) Rydb.]. Riddell probably should have written west instead of east, because of the prairie habitat in that area west of Worthington, rather than in the forest east of Worthington (R.L.S.).

30. Worthington: *Aster carneus* Nees var. *ambiguus* Torr. & A.Gray, Fl. N. Amer. 2:133. 1841 [*Aster lanceolatus* Willd. var. *interior* (Wiegand) Semple & Chmiel.; sometimes segregated from *Aster* as *Symphyotrichum lanceolatum* subsp. *lanceolatum* var. *interior* (Wiegand) G.L.Nesom].

****Aster oolentangiensis* Riddell, W.J. Med. Phys. Sci. 8: 495. 1835. Reprint p. 55. 1835 sometimes segregated from *Aster* as *Symphyotrichum oolentangiense* (Riddell) G.L.Nesom].

Prenanthes parviflora Riddell, W.J. Med. Phys. Sci. 8:490. 1835. Reprint p. 50 [*Prenanthes altissima* L.].

Stachys glabra Riddell, W.J. Med. Phys. Sci. 9: 580. 1836. Reprint p. 16. 1836 [*Stachys tenuifolia* Willd.].

GALLIA COUNTY

31. Gallipolis: *Crataegus horseyi* E.J.Palmer, Ohio J. Sci. 56:211–212. 1956 [*Crataegus intricata* Lange].

32. Gallipolis, banks of the Ohio River: ****Collinsia verna* Nutt., J. Acad. Nat. Sci. Philadelphia 1:190. 1817.

Discovium ohioense Raf., Autik. Bot. 17. 1840 [?*Lesquerella globosa* (Desv.) S.Watson].

GREENE COUNTY

33. Hoffman's Prairie, eight miles east from Dayton: *Amaranthus miamiensis* Riddell, W.J. Med. Phys. Sci. 8:367. 1835. Reprint p. 41. 1835 [*Amaranthus tuberculatus* (Moq.) J.D.Sauer].

****Solidago riddellii* Frank in Riddell, W.J. Med. Phys. Sci. 8: 497. 1835. Reprint p. 57. 1835. This locality is now referred to as the Wright Brothers Prairie or Wright Patterson Natural Area, which is located within the Wright Patterson Air Force Base east of Dayton, Ohio (Knoop, 2002).

34. Yellow Springs: *Asplenium cryptolepis* Fernald var. *ohionis* Fernald, Rhodora 30:43. 1928 [*Asplenium ruta-muraria* L., usually not recognized at the varietal level; when accepted, the correct epithet is in doubt as of this writing, but evidently would not be *ohionis*].

HAMILTON COUNTY

35. Cincinnati: *Aesculus maxima* D.Drake, Natural and Statistical View, or Picture of Cincinnati and the Miami Country ... p. 78. 1815 [1816] [*Aesculus flava* Aiton].

Enslenia albida Nutt., Gen. N. Amer. Pl. 1:164. 1818 [*Cynanchum laeve* (Michx.) Pers.].

****Erythronium albidum* Nutt., Gen. N. Amer. Pl. 1:223. 1818.

Synandra grandiflora Nutt., Gen. N. Amer. Pl. 2:29. 1818 [*Synandra hispidula* (Michx.) Baill.].

36. Three miles north of Cincinnati: **Quercus leana* Nutt., Sylva 1:13. 1849 [*Quercus ×leana* Nutt., pro sp.; = *Quercus imbricaria* Michx. × *Q. velutina* Lam.].

37. Near Terrace Park: ****Viola ×brauniae* Grover ex Cooperr., Michigan Bot. 25:108. 1986 [= *Viola rostrata* Pursh × *V. striata* Aiton].

HARDIN COUNTY

38. Mt. Victory: *Crataegus meiophylla* Sarg., J. Arnold Arbor. 3:198. 1922 [*Crataegus margaretta* Ashe].

HIGHLAND COUNTY

39. Rocky Fork Creek, 3/4 mile above junction with Paint Creek: **Saxifraga sullivantii* Torr. & A.Gray, Fl. N. Amer. 1:575. 1840; *Sullivantia ohionis* Torr. & A.Gray, Amer. J. Sci. 42:22. 1842, new name for same taxon [*Sullivantia sullivantii* (Torr. & A.Gray) Britton. This species is the type of the genus name *Sullivantia*, which was published in the same paper].

HOCKING COUNTY

40. Benton Township: Above Keifel Rd., 0.3 mi NE, jct of Big Pine Creek rd., Sect 7, Benton Township: **Lycopodium ×bartleyii* Cusick, Amer. Fern J. 77:100. 1987 [*Huperzia ×bartleyi* (Cusick) Kartesz & Gandhi; identified in original description by Cusick as *Lycopodium lucidulum* Michx. × *L. porophilum* F.E.Lloyd & Underw.; = *Huperzia lucidula* (Michx.) Trevis. × *H. porophila* (F.E.Lloyd & Underw.} Holub].

JACKSON COUNTY

41. Liberty Township, Ofer Hollow: **Calamagrostis insperata* Swallen, J. Wash. Acad. Sci.

25:413. 1935 [*Calamagrostis porteri* A.Gray subsp. *insperata* (Swallen) C.W. Greene].

LAKE COUNTY

42. Painesville: **Lonicera glaucescens* Rydb. var. *dasygyna* Rehder, Annual Rep. Missouri Bot. Gard. 14:181. 1903 [*Lonicera dioica* L. var. *dasygyna* (Rehder) Gleason].

Panicum werneri Scribn. ex Britton & A.Brown, Ill. Fl. N. U.S. 3:501 1898. [*Dichanthelium linearifolium* (Scribn. ex Britton & A.Brown) Gould; often retained in *Panicum*, as *P. linearifolium* Scribn. ex Britton & A.Brown].

Ribes cynosbati L. var. *glabratum* Fernald, Rhodora 7:156. 1905.

43. Richmond: **Helianthus brevifolius* E.Watson, Pap. Michigan Acad. Sci. 9:448. 1929 [*Helianthus ×brevifolius* E.Watson; pro sp.; = *Helianthus grosseserratus* M.Martens × *H. mollis* Lam.] .

LICKING COUNTY

44. Buckeye Lake, Cranberry Island: *Acer rubrum* L. var. *rubrocarpum* Detmers, "*rubro carpum*," Ohio J. Sci. 19:236. 1919.

Acer rubrum L. var. *viride* Detmers, Ohio J. Sci. 19:235. 1919.

45. Granville: *Scutellaria ovata* Hill subsp. *pseudo-venosa* Epling, Univ. California Publ. Bot. 20:56. 1942 [*Scutellaria ovata* Hill subsp. *ovata*].

LORAIN COUNTY

46. Oberlin: *Ribes cynosbati* L. var. *glabratum* Fernald, Rhodora 7:156. 1905; see also O.E. Jennings, Ohio Nat. 6:492–495. 1906.

47. Alson, Vermillion River: *Aloitis foliosa* Greene, Leafl. Bot. Obs. & Crit. 1:94. 1904 [*Gentianella quinquefolia* (L.) Small subsp. *occidentalis* (A.Gray) J.M.Gillett].

LUCAS COUNTY

48. Toledo: *Staphylea brighamii* J.F.Macbr., Rhodora 20:129. 1918 [*Staphylea trifolia* L.].

MADISON COUNTY

49. Darby Plains, 15 miles west of Columbus: ***Eleocharis compressa* Sull., Amer. J. Sci. Arts 42:49. 1842.

Helianthus cinereus Torr. & A.Gray var. *sullivantii* Torr. & A.Gray, Fl. N. Amer. 2:234. 1842 [*Helianthus ×cinereus* Torr. & A.Gray; pro sp.; = *Helianthus mollis* L. × *H. occidentalis* Riddell]

MEIGS COUNTY

50. North of Dexter; sandstone exposures on mesic slop above Leading Creek, Co. Rt 10, 0.25 mi (0.02 km) SW of Twp Rt 27, Sec. 6, Salem Twp: *Polypodium ×incognitum* Cusick, Amer. Fern J. 92:241. 2002 [= *Polypodium appalachianum* Hauffler & Windham × *P. virginianum* L.].

MONTGOMERY COUNTY

51. Dayton: *Prenanthes miamiensis* Riddell, W.J. Med. Phys. Sci. 8:490. 1835. Reprint p. 50. 1835 [*Prenanthes crepidinea* Michx.].

"Bushy Prairie, Dayton, O." *Prenanthes ovata* Riddell, W.J. Med. Phys. Sci. 8:490. Reprint p. 50. 1835 [*Prenanthes alba* L.].

52. Van Cleve's Prairie, Dayton: ***Solidago ohioensis* Riddell, W.J. Med. Phys. Sci. 8:497. 1835. Reprint p. 57. 1835 [sometimes segregated from *Solidago* as *Oligoneuron ohioense* (Riddell) G.N.Jones].

OTTAWA COUNTY

53. Catawba Island: *Persicaria laurina* Greene, Leafl. Bot. Observ. Crit. 1:35. 1904; see also O.E. Jennings, Ohio Naturalist 6:492–495. 1906.

54. South Bass Island: ***Polygonum pensylvanicum* L. var. *eglandulosum* J.C.Myers, Castanea 7:74. 1942.

Rubus corei L.H.Bailey in Core, Franz Theodore Stone Lab. Contrib. 9:70. 1948 [*Rubus alumnus* L.H.Bailey].

Rubus eriensis L.H.Bailey in Core, Franz Theodore Stone Lab. Contrib. 9:70. 1948 [*Rubus frondosus* Bigelow].

Rubus gordonii L.H.Bailey in Core, Franz Theodore Stone Lab. Contrib. 9:70. 1948 [*Rubus deamii* L.H.Bailey].

PORTAGE COUNTY

55. Garrettsville: *Crataegus marcida* Ashe, J. Elisha Mitchell Sci. Soc. 20:53. 1904 [*Crataegus iracunda* Beadle].

56. Windham: *Athyrium angustum* (Willd.) C.Presl var. *cristatum* Hopkins, Amer. Fern J. 9:86. 1919 [*Athyrium filix-femina* L. var. *angustum* (Willd.) G.Lawson; sometimes treated as *A. angustum* (Willd.) C.Presl].

57. Woodworth's Glen: *Cystopteris fragilis* (L.) Bernh. var. *cristata* Hopkins, Ohio Nat. 10:181. 1910, not E.J.Lowe 1869 [*Cystopteris tenuis* (Michx.) Desv.].

RICHLAND COUNTY

58. Mansfield: *Crataegus decens* Ashe, J. Elisha Mitchell Sci. Soc. 19:19. 190 [*Crataegus lucorum* Sarg.].

Crataegus habilis Ashe, Bot. Gaz. 35:435. 1903.

***Crataegus indicens* Ashe, J. Elisha Mitchell Sci. Soc. 19:27. 1903.

Crataegus mansfieldensis Sarg., J. Arnold Arbor. 4:103. 1923 [*Crataegus irrasa* Sarg.].

Crataegus onusta Ashe, J. Elisha Mitchell Sci. Soc. 19:22. 1903 [*Crataegus pruinosa* (H.L.Wendl.) K.Koch].

Crataegus prona Ashe, J. Elisha Mitchell Sci. Soc. 19:17. 1903 [*Crataegus macrosperma* Ashe].

Crataegus wilkinsonii Ashe, Bot. Gaz. 35:435. 1903, "*wilkinsoni*" [*Crataegus crus-galli* L.].

Thalictrum amabile Greene, Amer. Midl. Naturalist 2:294. 1912 [*Thalictrum revolutum* DC.].

ROSS COUNTY

59. Chillicothe, three miles southwest: ***Scutellaria saxatilis* Riddell, W.J. Med. Phys. Sci. 9:578. 1836. Reprint p. 14. 1835.

SCIOTO COUNTY

60. Portsmouth, banks of the Scioto River: *Enslenia albida* Nutt., Gen. N. Amer. Pl. 1:164. 1818 [*Cynanchum laeve* (Michx.) Pers.].

Scutellaria canescens Nutt., Gen. N. Amer. Pl. 2:38. 1818 [*Scutellaria incana* Biehler].

61. Junction of the Ohio River and Scioto River: *Eupatorium falcatum* Michx., Fl. Bor. Amer. 2:99. 1803 [*Eupatorium purpureum* L. var. *purpureum*; sometimes placed in *Eupatoriadelphus*, as *E. purpureum* (L.) R.M.King & H.Rob.].

***Kyllingia pumila* Michx., Fl. Bor.-Amer. 1:28. 1803 [sometimes placed in *Cyperus*, as *C. tenuifolius* (Steud.) Dandy].

TRUMBULL COUNTY

62. Leavittsburg: *Crataegus marcida* Ashe, J. Elisha Mitchell Sci. Soc. 20:53. 1904) [*Crataegus iracunda* Beadle].

TUSCARAWAS COUNTY

63. Dennison: *Crataegus kellermanii* Sarg., Trees & Shrubs 2:239. 1913 [*Crataegus suborbiculata* Sarg.].

64. Dover: *Habenaria retusa* Riddell, W.J. Med. Phys. Sci. 9:581. 1836. Reprint p. 17. 1836, not Rodrigues 1882.

***Helianthus occidentalis* Riddell, W.J. Med. Phys. Sci. 9:577. 1836. Reprint p. 13. 1836.

***Linum sulcatum* Riddell, W.J. Med. Phys. Sci. 9:574. 1836. Reprint p. 10. 1836.

65. Near Muskingum River [= Tuscarawas River, probably near Gnadenhutten]: ***Carex muskingumensis* Schwein., Ann. Lyceum Nat. Hist. New York 1:66. 1824; 1:312. 1825.

WARREN COUNTY

66. [South] Lebanon: **Seymeria macrophylla* Nutt., Gen. N. Amer. Pl. 2:49. 1818 [*Dasistoma macrophylla* (Nutt.) Raf.].

WASHINGTON COUNTY

67. Marietta: *Crataegus mariettensis* Sarg., J. Arnold Arbor. 3:194. 1922 [*Crataegus dissona* Sarg.].

Crataegus putnamiana Sarg., J. Arnold Arbor. 4:102. 1923 [*Crataegus chrysocarpa* Ashe].

Stylophorum petiolatum Nutt., Gen. N. Amer. Pl. 2:8. 1818 [*Stylophorum diphyllum* (Michx.) Nutt.].

68. Bank of the Muskingum River at Marietta: *Justicia pendunculosa* Michx., Fl. Bor.-Amer. 1:7. 1803; see also Proc. Amer. Philos. Soc. 26:94. 1889 [*Justicia americana* (L.) Vahl].

WAYNE COUNTY

69. Rocky wooded hillsides: *Adiantum pedatum* L. var. *laciniatum* Hopkins, Ohio Naturalist 10:180. 1910.

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THE EAST-WEST TRANSITION OF THE FLORA IN TEXAS: A BIOGEOGRAPHICAL ANALYSIS

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ABSTRACT

Quantitative methods were used to determine the transition zone between the eastern and western flora in Texas. The transition between the southeastern deciduous/coniferous forest region and the western plains/brushy-savanna is a 300 km wide area extending from around 95 degrees to 99 degrees west longitude. Across this area, eastern and western species drop out precipitously; this area is the range edge for the two floras. This finding agrees closely with earlier vertebrate biogeographic analyses.

KEY WORDS: West Gulf Coastal Plain, flora, biogeography, east-west floristic transition, Texas

RESUMEN

Se usaron métodos cuantitativos para determinar la zona de transición entre la flora oriental y occidental en Texas. La transición entre la región sur oriental de bosques deciduos/coníferas y la occidental de llanuras/sabana arbustiva es un área de 300 km de ancha que se extiende desde unos 95 grados a 99 grados de longitud oeste. A través de esta área, las especies orientales y occidentales se separan precipitadamente; esta área es el extremo del rango de las dos floras. Este hallazgo concuerda en gran medida con análisis biogeográficos realizados previamente.

INTRODUCTION

Despite the fact that the North American coastal plain is one of the continent's major floristic provinces (Dice 1943; Takhtajan 1986), quantitative papers on its phytogeography are poorly represented in the botanical literature (Sorrie & Weakley 2001). Even more poorly represented are such papers on the West Gulf Coastal Plain (MacRoberts et al. 2002; MacRoberts & MacRoberts 2003). While several quantitative studies are now available on endemism within the coastal plain (Sorrie & Weakley 2001; MacRoberts et al. 2002), studies on diversity, species richness, dispersion barriers, and floristic boundaries are lacking (Currie 1991; MacRoberts & MacRoberts 2003).

It has been long known that the eastern part of the West Gulf Coastal Plain (east Texas, south Arkansas, west Louisiana, southeast Oklahoma) is part of the eastern and notably the southeastern United States (Thorne 1993; Christensen 2000; Delcourt & Delcourt 2000), but it is unclear where the floristic east-west

transition occurs. An examination of the ecoregional literature indicates a rather confused picture of this transitional area (MacRoberts & MacRoberts 2003).

The purpose of this paper is to determine where floristic east meets west in the West Gulf Coastal Plain.

METHODS

1) In order to obtain a characteristic sample of the southeastern flora at the same latitude as Texas, we used Kartesz and Meacham (1999) to determine the distribution of all North American vascular plants whose distribution includes Georgia, Florida, Alabama, and Mississippi (although not necessarily restricted to that area) and that cross the Mississippi River into Louisiana and/or Texas (although not necessarily restricted to that area). Thus, species restricted to only the above listed states are included (e.g., *Xyris drummondii* Malme) as well as those found in all of the contiguous 48 states and Canada (e.g., *Potamogeton pusillus* L.). Exotic species and hybrids are excluded. Subspecies and varieties are lumped with species. Species whose taxonomic status or distribution was questionable are excluded. Our initial data set contained 1320 species.

Since there is no thorough county-by-county floristic inventory of the West Gulf Coastal Plain, we used a single source of data, which consists of samples from those counties. We plotted the distribution of species that met our criterion by Texas counties using the Texas Consortium database (TAMU-BWG Herbarium Specimen Browser, a consortium of seven Texas herbaria with 130,000 records online). Of the 1320 species in the initial data set, 1138 were in the TAMU database by county. In the preliminary analysis all data were converted to percentages because the counties have been unevenly collected and reported. Thus, Bowie County had 489 species in the TAMU database, of which 302 were from our data set (302/489 = 0.62) and Madison Co. had 1016 species, of which 452 were from our data set (452/1016 = 0.44).

2. In order to do the same thing but from a west-to-east perspective, we sampled the western flora by roughly the same methods as described above. Because both New Mexico and Mexico border Texas on the west, we selected three counties in west Texas (Taylor, Tom Green, Edwards), listed the species found in them from TAMU data base, and randomly selected 313 from the list on the basis of their western affinity (found in west Texas, New Mexico and/or Mexico [TAMU; Kartesz & Meacham 1999]). We used a much smaller sample from the west because we realized that the eastern sample was larger than necessary. Because the sample is smaller, to make numbers comparable with the east we multiplied the percentages by 2.

We then converted all of the county data in 1 and 2 above to the Owen and Schmidly (1986) quadrat system for Texas to standardize area and to even out irregular county boundaries and percentages. This also allowed us to use Owen and Schmidly's data on environmental variables of biological importance. The

quadrats are 63.9 km on a side, overlaid on a Lambert's conical projection map of Texas. We converted the county data to quadrat data by overlaying the quadrat map onto our county map and then averaging the percent of species of the counties that occurred in each quadrat.

3) Having found a clear east-west transition zone from the results of numbers 1 and 2 (see below), we wished to document the floristic affinities of Texas along an east-west gradient more thoroughly. To do this, we selected four Texas counties (Tyler, Madison, Bell, Irion) running across Texas at approximately 31 degrees North latitude and sampled them to determine their floristic relationship to the surrounding states. Using the TAMU database, we selected a random list of between 200 and 250 native species from each county. We then plotted the United States/Canada distribution of all species in the four lists using Kartesz and Meacham (1999). As before, the results are expressed as percentage of the sample (e.g., Louisiana had 97 percent of the species in Tyler County).

RESULTS

Figure 1 shows the percentage of eastern and western species in samples according to longitude across Texas. Figure 2 shows these data summarized for Owen and Schmidly (1986) quadrats by ten percent intervals. Figure 3 shows the distribution across North America of the flora of four Texas counties.

DISCUSSION

An examination of the shape of the curves in Figure 1 and the gradient expressed in Figure 2 shows that along Texas' 1250 km east-west axis, the area of most significant change in eastern and western species is the approximately 300 km wide zone from Houston and Tyler on the east (approximately 95 degree W. longitude) to Wichita Falls and San Antonio on the west (approximately 99 degrees W. longitude). On either side of this area, the change is gradual. According to our analysis, Fort Worth, Austin, and Corpus Christi appear to be the point at which east and west are balanced (97 degrees West longitude).

The relationship between county affiliation in the broader context of the entire North American continent north of Mexico shows the same pattern. Tyler County in east Texas is floristically eastern. Madison County farther west is mainly eastern, Bell County in the center of the transition zone is intermediate, and Irion County in the west is western (Fig. 3).

While ours is not a study of species richness, ecoregion boundaries, or diversity, nor is it concerned with cause of the species transition, it has implications for such studies. For example, Currie (1991) in a study of species richness has shown that the east-to-west loss of tree species across the gulf coastal plain correlates most strongly with actual evapotranspiration, which is correlated with primary production and is, therefore, a measure of available environmental energy.

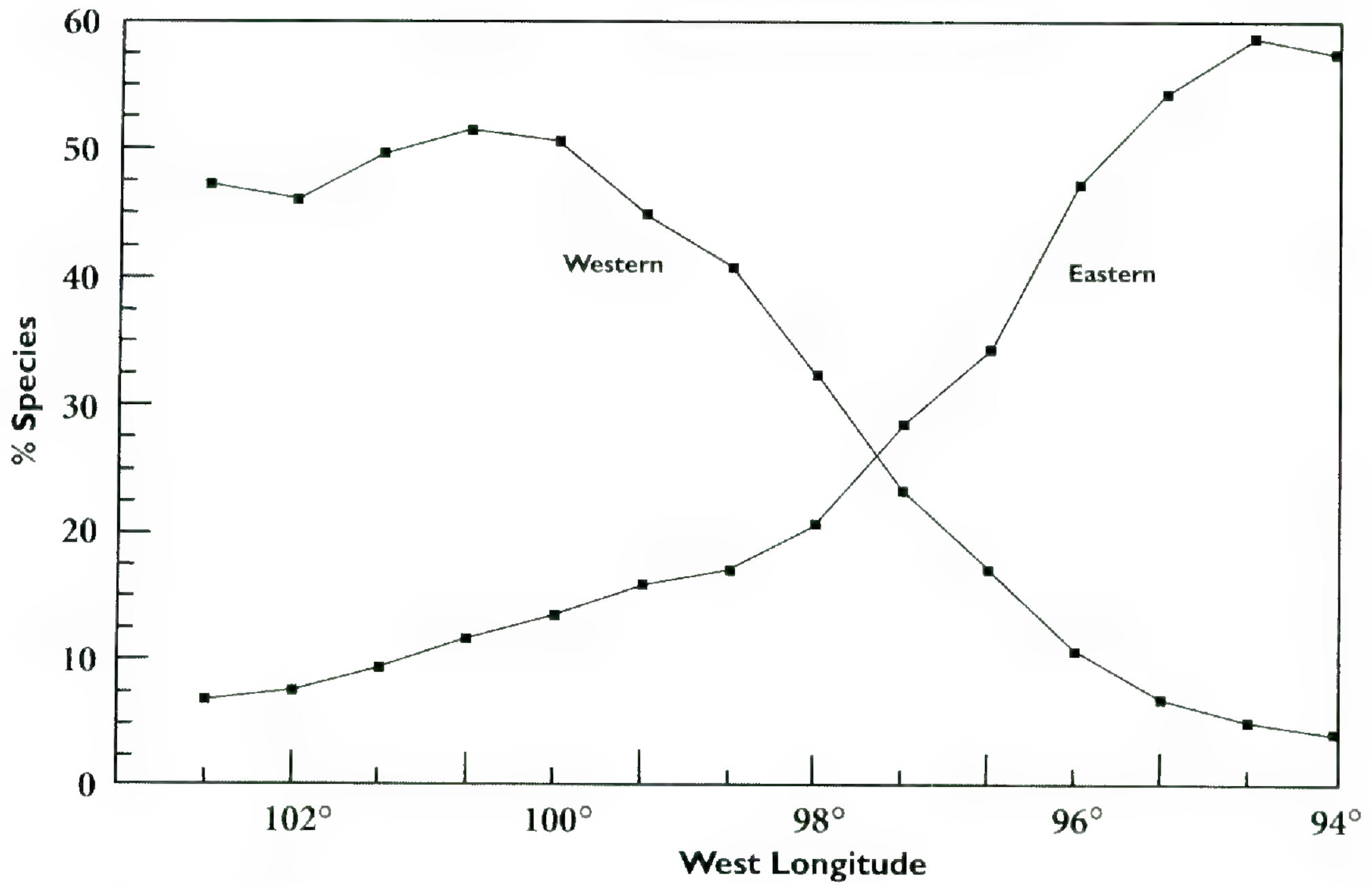


FIG. 1. Percentage of eastern and western species in samples according to longitude across Texas.

Our study also indicates that similar variables are important in determining species distribution in the West Gulf Coastal Plain. Using Owen and Schmidly's (1986) data, we calculated the correlation coefficient of "productivity" for eastern and western species and found a strong correlation between productivity across Texas and the number of eastern and western species. Eastern species correlated positively (Pearson = 0.91, Spearman = 0.92) while western species correlated negatively (Pearson = - 0.82, Spearman = - 0.77). The transition zone between east and west is after all the precipitation transition zone as well.

Central Texas has long been known to be an east-west transition zone, at least for vertebrates (Blair 1950; Webb 1950; Gehlbach 1991; Ward et al. 1994; Schmidly 2002). Dice (1943) referred to this area as the "Texan Biotic Province" between the eastern forest region ("Austroriparian") and the semi-arid brushy/savanna-grasslands ("Comanchian") of the western part of Texas. Blair (1950) recognized that the "Texan" was a "transitional region"—even using the word "ecotone"—but could find no alternative but to keep it a distinct province. Gehlbach (1991) solved the problem simply by pointing out that central Texas is a transition zone, not a biotic province, between the eastern deciduous forest region (Austroriparian Biotic Province) and western semi-arid brushy-savanna region (Comanchian Biotic Province). Characteristic plants and animals of both the Comanchian and Austroriparian occur locally in the Texan. More recently, Diggs et al. (1999:4) have characterized north central Texas floristically as "a

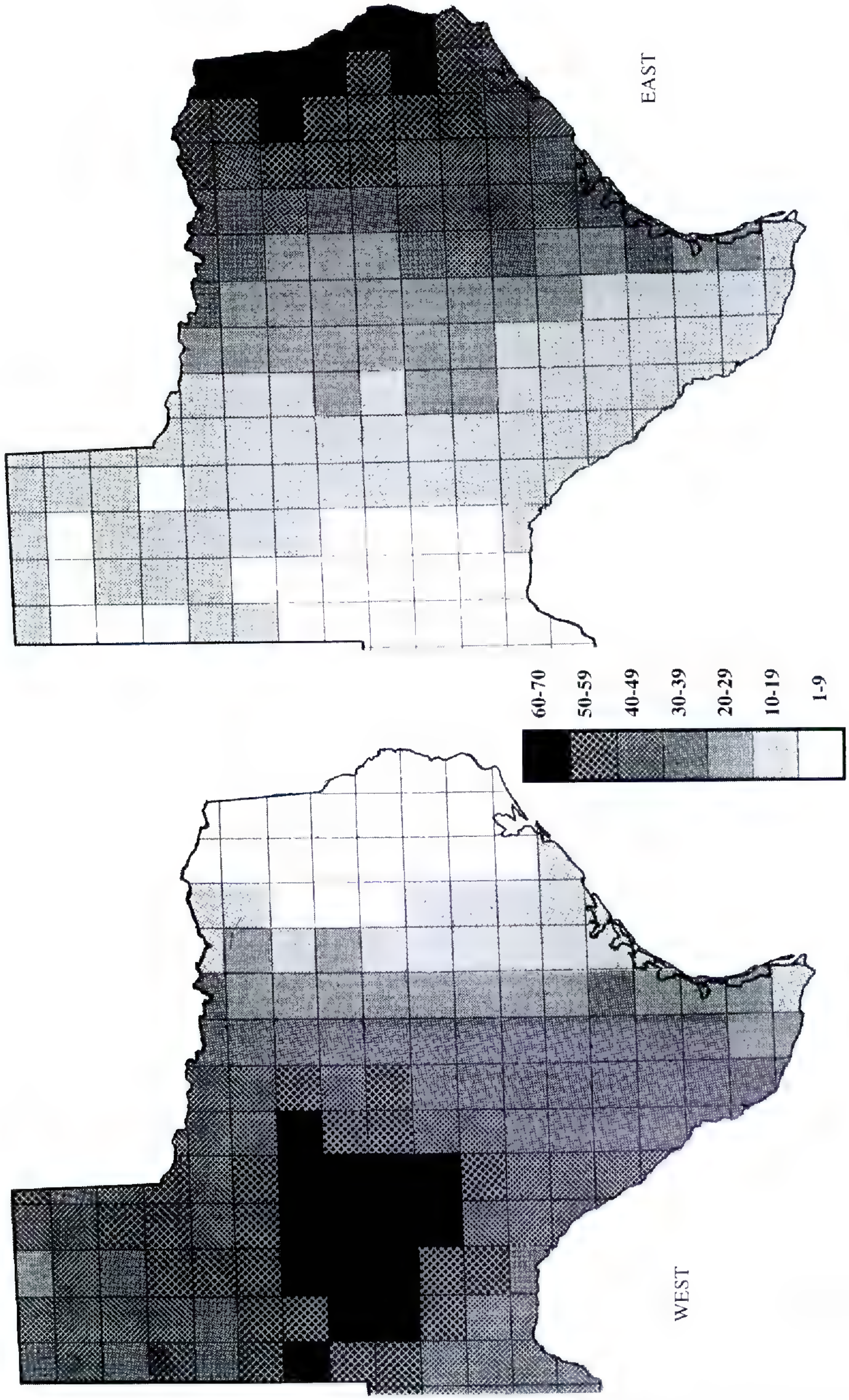


FIG. 2. Percentage of eastern and western species in samples according to Owen and Schmidly (1986) quadrat system at ten percent intervals.

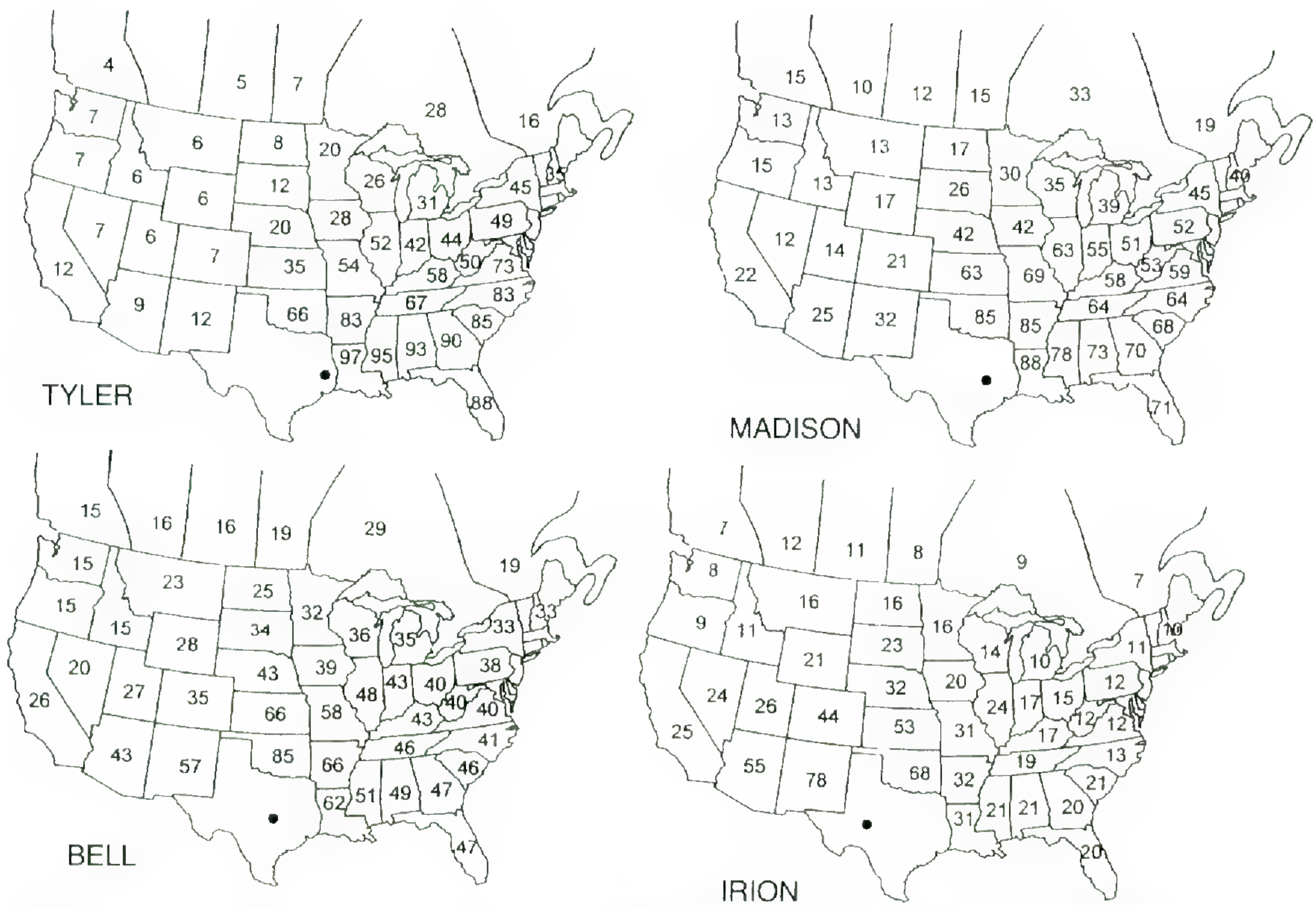


FIG. 3. Percentage of states, provinces, and geographical areas having species in samples from Tyler, Madison, Bell, and Irion counties, Texas.

broad ecotone between eastern deciduous forest and western grassland." We concur with these characterizations. From a floristic perspective, there is an east-west transition in the area roughly designated as Texan Biotic Province.

Paleoenvironmental studies indicate that the current floristic character of Texas may be fairly recent. Pleistocene and Holocene climatic changes appear to have been significant with the invasion of the West Gulf Coastal Plain by southeastern and Mexican species since the last glacial retreat (Bousman 1998; Delcourt & Delcourt 2000).

We do not consider our overall findings particularly novel. Years ago, zoologists came to basically the same conclusions based on vertebrate distribution. West Gulf Coastal Plain botanists, however, have been slow to address biogeographic questions quantitatively. As a result, botanists and botanically inclined ecologists have created a plethora of qualitatively defined "ecoregions" across Texas (Webb 1950; MacRoberts & MacRoberts 2003). We believe that zoologists currently have a better understanding of the biogeographic regions of Texas than do botanists, but improved plant distributional data (e.g., Turner et al. 2003) and the replacement of qualitative by quantitative methods of investigation should soon provide botanists with the opportunity to rectify this situation. With better data, and thus the ability to make finer comparisons, it will

be interesting to see just where the transition is most pronounced and how west and south Texas separate from the remainder of Texas and the southeast.

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REDISCOVERY OF *TEPHROSIA JAMNAGARENSIS* (FABACEAE), AN ENDANGERED AND NARROW ENDEMIC PLANT SPECIES OF SAURASHTRA, GUJARAT, INDIA

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ABSTRACT

During recent botanical explorations of Saurashtra, Gujarat, India, the narrowly endemic plant species *Tephrosia jamnagarensis* was rediscovered after a lapse of 3 decades. A full description of the species is provided along with photographs; a key to closely related species is included.

RESUMEN

Durante exploraciones botánicas recientes en Saurashtra, Gujarat, India, la especie endémica *Tephrosia jamnagarensis* fue redescubierta después de un intervalo de tres décadas. Se ofrece una descripción completa de la especie junto con fotografías y se incluye una clave para las especies relacionadas más próximas.

INTRODUCTION

During a floristic survey of Jamnagar District (Nagar 2002), *Tephrosia jamnagarensis* Santapau—an endangered and endemic species of Saurashtra (Kothari & Hajra 1983; Nayar & Sastry 1988; Santapau 1958; Shah 1983)—was collected from the lower slopes of the Khad Khambhaliya Vidi (Grassland), Lalpur Taluka, Jamnagar District, Gujarat, India. Fieldwork in 2001 verified the occurrence from Jamnagar District, though not from the same locality.

Tephrosia jamnagarensis was not recognized as a distinct species in earlier floras of the state (Cooke 1901–1903; Thaker 1910). The specific epithet *jamnagarensis* refers to the type locality.

The species was collected for the first time by Santapau (*Santapau 7522*) near Rozi, Jamnagar District, Gujarat, India in 1945 (Santapau 1958) and for the second time some 11 years later (24 Aug 1954) from Victoria Bridge, Jamnagar District (Santapau 1962). A few plants were collected in 1972 from wastelands near the cultivated fields of Bhadbhut, close to Bharuch (South Gujarat), a different sub-humid geographical region (Shah 1978; Vyas 1973). A recent survey

for T. *jamnagarensis* in these same locations did not locate it. The areas have been mostly converted to agricultural land (Nagar 2000; Rao 2002). The recent collections of *T. jamnagarensis* represent not only the rediscovery of this very interesting taxon—after a gap of almost 3 decades—but are also the first available collections that allow for a full description of the flower.

With this recent collection in flower and fruit, a detailed description of the species with floral characteristics, phenology, and habit and habitat distribution is given; photographs are provided.

DESCRIPTION OF *TEPHROSIA JAMNAGARENSIS* AND ITS COMPARISON WITH *TEPHROSIA STRIGOSA*

Tephrosia jamnagarensis Santapau in Proc. Natl. Inst. Sci. India 24B:133, t. 1. 1958. (**Fig. 1**). TYPE: INDIA. GUJARAT. Jamnagar District: near Rozi, 16 Oct 1945, *Santapau 7522* (HOLOTYPE: BLAT).

Erect or suberect, annual herb; stems simple or sparsely branched, covered with whitish appressed hairs. Leaves simple, 3–5.2 × 5–9 mm, linear, glabrous adaxially, densely hairy with silvery appressed hairs abaxially, subobtuse and clearly apiculate at apex, acute at base; lateral nerves 25–30 pairs, parallel; margin entire, with a nerve running from near the base to the apex very near the margin; the nerves covered with hairs, distinct on the adaxial surface, equally distinct on the abaxial surface. Petioles 2–3 mm, hairy; stipules subulate, 3–4 mm, hairy. Flowers single or in pairs, axillary; pedicels 2–3 mm, about as long as the petioles, densely hairy. Calyx, 1–3 mm, hairy, the teeth subulate, filiform, subequal. Corolla mauve, 2.5–3 mm (standard 3 mm, wings 2–2.5 mm, keel 2.5 mm). Legumes compressed, ca. 20 × 5 mm, densely and patently hairy with grayish tinge, oblique at both ends, apiculate; seeds 5–6, reniform, dull or matt, brownish.

Tephrosia jamnagarensis is similar to *T. strigosa* (Dalz.) Sant. & Mahesh, differing mainly by its broader (twice as broad as in *T. strigosa*), densely pubescent pods and by its larger leaves with densely appressed hairs on the abaxial surface, which is clearly silvery or densely argenteo-canescent, making it very distinct from *T. strigosa*. The pedicels are shorter and stouter than in *T. strigosa*. The seeds are not separated by any internal partition (partitioned in T. *strigosa*).

Voucher specimens: **INDIA. Gujarat. Jamnagar District:** Lalpur Taluka: Khad khmbaliya Vidi (Grassland), 17 Oct 2001, *P.S. Nagar 1221, 1222, 1234, 1235* (SAUUNI= Saurashtra University).

Additional specimens examined: **INDIA. Gujarat. Jamnagar District:** near Rozi, 16 Oct 1945, *Santapau 7522* (HOLOTYPE: BLAT); Bhadbhut, 12 Oct 1972, *K.J. Vyas 3095* (spu); Bharuch, 18 Sep 1972, *K.J. Vyas 2664* (spu); 21 Sep 1972, *K.J. Vyas 2946* (spu). Specimens other than the holotype are deposited in the herbarium of Department of Biosciences, Sardar Patel University (spu), Vallabhvidyanagar, Gujarat, India.

Phenology and Associated Species.—The plants were in flower from September to October, in fruit, from October to November. They grew in grassland with

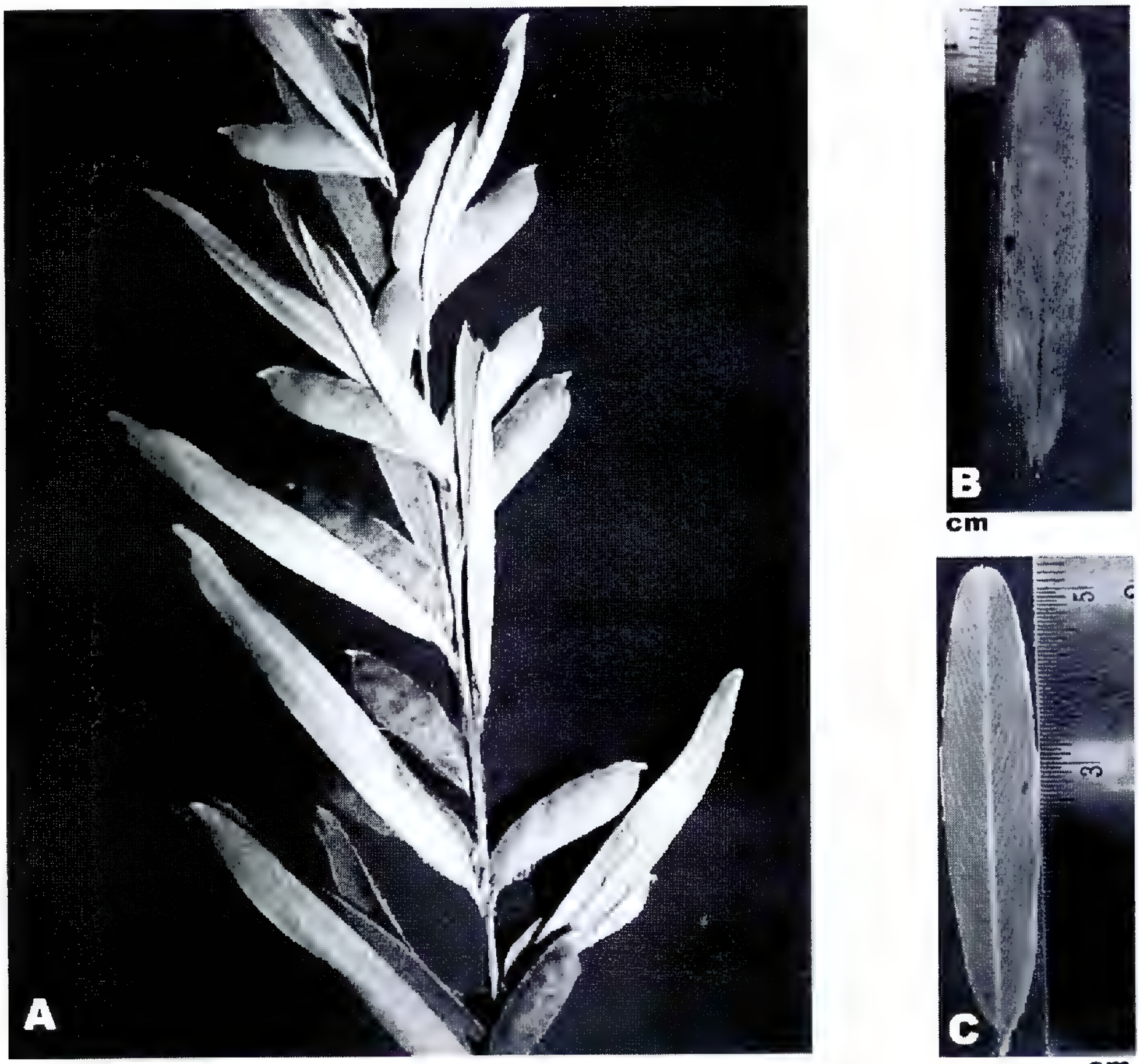


FIG. 1. *Tephrosia jamnagarensis* Santapau **A.** Habit, Leaf; **B.** Adaxial surface; **C.** Abaxial surface; **D.** Flowering twig; **E.** Calyx; **F.** Ovary; **G.** Pod; **H.** Seed ornamentation; **I.** Seeds.

Chrysopogon fulvus (Spr.) Choiv., *Sehima nervosum* (Rottl.) Stapf, *Hetropogon contortous* (L.) P. Beauv. ex R. & S., *Aristida sp.*, *Borreria stricta* (L.f.) K. Schum, *Zornia diphylla* auct., *Indigofera cordifolia* Heyne ex Roth, *Indigofera tinctoria* L., and *Alysicarpus vaginalis* (L.) DC.

Habitat and Population Status.—The plants were growing on calcareous gravelly soil. The species is very rare. A quantitative analysis of the population indicated an estimated density of 0.24 plants/m^2 and frequency of occurrence of 6% (India: Gujarat. Jamnagar District. Khadkhambaliya Region, Lalpur Taluka (Nagar 2002). The rarity of the plant is probably due to overgrazing, habitat destruction, lack of protection, and probably other biotic factors. The plant has been listed as rare under threat category (Botanical Survey of India 1993; WCMC 1994).

Distribution.—The geographical range of *T. jamnagarensis* Sant. is restricted to two separate regions: the western group of populations in northwestern Jamnagar (Rozi and Khadkhambaliya) and the southern population in southwest Bharuch.

Potential Value.—Several species of *Tephrosia* [e.g., *T. purpurea* (L.) Pers.] are sometimes grown as green manure and as cover crops (Santapau 1962); *T. purpurea* is useful medicinally [the whole plant is used internally as purgative, laxative, and tonic; externally it is applied on skin boils (Thaker 1910)]. It is likely that *T. jamnagarensis* may also have similar properties.

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Contents.—**1)** Overview; **2)** Botany of *Stevia and Stevia rebaudiana*; **3)** Ethnobotany of *Stevia and Stevia rebaudiana*; **4)** Sweet and non-sweet constituents of *Stevia rebaudiana*; **5)** The phytochemistry of *Stevia*: a general survey; **6)** Synthetic investigations on steviol, stevioside, and rebaudioside A, and their applications as starting materials; **7)** Methods to improve the taste of the sweet principles of *Stevia rebaudiana*; **8)** Pharmacology and toxicology of stevioside, rebaudioside A, and steviol; **9)** Use of *Stevia rebaudiana* sweeteners in Japan; **10)** Use of stevioside and cultivation of *Stevia rebaudiana* in Korea; and Index.

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DOES *POLYGONUM PATULUM* (POLYGONACEAE) GROW IN NORTH AMERICA?

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ABSTRACT

Plants previously considered *Polygonum patulum* Bieb in California are within the range of variation of *Polygonum ramosissimum* Michx. complex. The real *Polygonum patulum* is recorded now for the first time from Alabama, Illinois, Utah and Washington, where it has occurred as a rare ruderal.

RESUMEN

Las plantas consideradas previamente *Polygonum patulum* en California se encuentran dentro del rango de variación del complejo de *Polygonum ramosissimum*. El verdadero *Polygonum patulum* es citado ahora por primera vez en Alabama, Illinois, Utah y Washington, donde ha aparecido como un ruderal raro.

The Eurasian and North African *Polygonum patulum* M. Bieb. has been listed in all standard Californian floras (e.g., Munz & Keck 1968; Hickman 1993). However, Hickman (1993) noted that the "applicability of this name to Californian plants remains uncertain." After comparing these plants with the European specimens of *P. patulum*, we can confirm that they do not belong to this species. The Californian plants resemble *P. patulum* in having a terminal spiciform inflorescence (with the leaves in the upper part of inflorescence reduced to bracts which are shorter than the flowers they subtend) and small flowers and fruits of 2.5–3 mm, and 2.2–3 mm, respectively. However, the achenes of *P. patulum* are striate-tubercled, and the inner and outer tepals have about the same length. Plants from California have smooth to roughened achenes, and the inner tepals are evidently shorter than the outer tepals. Many of these plants are identical to some of the specimens quoted by Small when he described *P. exsertum* (Small 1894): **United States of America**. **Missouri:** St. Louis, Sep 1845, *G. Engelmann s.n.* (NY). **NEBRASKA**: Valentine, 1891, *J.M. Bates s.n.* (NY). Unfortunately, the protologue and the subsequent descriptions of *P. exsertum* have placed emphasis only on the much elongated late-season achenes, which are taxonomically irrelevant (e.g. Fernald 1950). The morphology of the perianth and achenes during early summer has been not explored. Consequently, *P. exsertum* has been considered by all the authors to be a synonym of *Polygonum ramosissimum* (e.g. Gleason 1952; Mertens & Raven 1965; Wolf & McNeill 1986).

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Polygonum ramosissimum is a complex species similar in that regards to *P. aviculare* (Costea & Tardif 2003). *Polygonum exsertum* and possibly other species previously synonymized with *P. ramosissimum*, may deserve taxonomic recognition as infraspecific taxa of *P. ramosissimum*. Nevertheless, further research is needed to understand the patterns of variation within *P. ramosissimum*. For the time being, it is safe to conclude that what has been considered *P. patulum* in California is within the range of *P. ramosissimum* variation.

The real *P. patulum* is a rare adventive in North America. During the preparation of the genus *Polygonum* for Flora of North America we have found only a few collections in the United States of America that can be ascribed to this taxon, and these are new floristical records. Except for *P. ramosissimum*, *P. patulum* may be mistaken only with *P. argyrocoleon* Steud. ex Kunze. The latter has smooth achenes and the terminal spiciform inflorescence is congested, dense, with cymes having 4–5 flowers. *Polygonum patulum* has striate-tubercled achenes, and the terminal inflorescence is open, with cymes having 1–4 flowers.

Typical specimens examined: **U.S.A. ALABAMA. Mobile Co.:** Mobile, adventive with ballast, Oct 1893, *C. Mohr s.n.* (NY). **ILLINOIS. Union Co.:** 4.3 mi S of Jonesboro, disturbed clay, rather common roadside weed, 23 Sep 1999, *S.R. Hill 32090* (NY). **UTAH. Uintah Co.:** NW corner of Pelican Lake, 1250 m, in moist soil of edge of lake, 8 Aug 1983, *E. Neese 14645* (NY). **WASHINGTON. Grays Harbor Co.:** Montesano, in fields, Sept 1917, *J.M. Grant* (NY).

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POLYGONUM AVICULARE SUBSP. *RURIVAGUM* (POLYGONACEAE) IN NORTH AMERICA

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ABSTRACT

The occurrence of *Polygonum aviculare* subsp. *rurivagum* in North America is confirmed. The taxon is a rare adventive from Europe growing in sunny, dry and trampled ruderal habitats.

RESUMEN

La presencia de *Polygonum aviculare* subsp. *rurivagum* en Norteamérica es confirmada. Es un taxon raro originario de Europa que crece en lugares ruderales, soleados, secos y pisoteados.

The occurrence of the European *Polygonum aviculare* L. subsp. *rurivagum* (Jord. ex Boreau) Berher in North America has been uncertain. Löve and Löve (1956) reported it from eastern North America but they did not indicate any location. Furthermore, their results have been generally disregarded because of some doubtful chromosome counts, and because no specimens or vouchers have been quoted or found (e.g., Mertens & Raven 1965; Wolf & McNeill 1986). During the preparation of the genus *Polygonum* for Flora of North America we have encountered this taxon in scattered locations in North America and we compared it with European material. Some relatively recent European floras and treatments of *Polygonum* have preferred to treat this taxon as a species (*P. rurivagum* Jord. ex Boreau, e.g., Akeroyd 1993; Do Amaral Franco & Da Luz Rocha Afonso 1995; Stace 1997) following the study of Styles (1962). Nevertheless, its classification under *P. aviculare* is apparently the best solution (Karlsson 2000; Costea & Tardif 2003). It is a rare but homogenous taxon. Its extreme morphology, with paucif lorous cymes (1–3 f lowers), small f lowers, 2.3–3.2 mm, and narrow-elliptic to linear-lanceolate leaves, 1.5–5 mm wide, brings it close to *P. aviculare* subsp. *neglectum* (Besser) Arcang., with which it has been frequently misidentified. The subsp. *rurivagum* differs by the long ochreas, 8–12.5 mm, with strong veins and the free part disintegrating into persistent fibers, and by the leaves with lateral veins strongly raised on the abaxial part of the leaves. The subspecies *neglectum* has ochreas of 4–8 mm, with inconspicuous veins and free part leaving almost no fibrous remains and leaves without strongly raised lateral veins. For differences between subsp. *rurivagum* and the other subspecies of *P.*

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aviculare from North America see Costea and Tardif (2003). For iconography see Raffaelli (1982, Fig. 12), Karlsson (2000, Fig. 96). The plant grows as a ruderal in dry, sunny and often trampled habitats, in pavement cracks, gravel and sandy places. Flowering occurs from June to October.

Typical specimens examined: **CANADA. ALBERTA:** S of Cypress Hills, barren flats and roadside ditch, 16 Aug 1951, *E.H. Moss 9632* (ALTA); 2.25 mi S of Fort Saskatchewan, 8 Aug 1944, *E.H. Moss & G.H. Turner 6642* (ALTA, DAO); Ma-Me-O Beach, edge of paved highway, 33 Jul 1957, *G.H. Turner 9535* (ALTA, DAO). **MANITOBA:** Otterburne, en bordure de la voie ferrée, au nord de la localité, 13 Aug 1956, *J.-P. Bernard 5586a* (QFA). **NEW BRUNSWICK. Cloucester Co.:** near Caraquet, on riverbank, 22 Jul 1945, *W.G. Dore & E. Gorham 45753* (MT). **NEW FOUNDLAND. Hermitage Distr.:** Harbor Breton, brackish pond behind beach, muddy gravelly shore, 19 Jul 1989, *A. Bouchard et al. 89250* (MT). **QUEBEC. Comté de Bagot:** St-Pie, 40°30'N, 72°54W, sous le pont traversant la rivière Yamaska; terrain vague, près des piliers du pont du côté est de la rivière, avec *Polygonum ramosissimum*, 12 Sep 1992, *M. Blondeau 92154* (QFA). **Comté de Rimouski:** Le Bic, prairie saumâtre avec: *Salicornia, Spartina patens, Limonium*, etc., 16 Aug 1962, *Rolland-Germain 8202* (MT). **SASKATCHEWAN. Regina Distr.:** Regina, disturbed empty lot N of Luther Care Home, 21 Aug 2000, *G.E. Ledingham 13707* (USAS).

U.S.A. CALIFORNIA. Kern Co.: Breckenridge Mountain Road, at the S fork of Lucas Creek, 1833 m, yellow pine forest, 27 Jul 1965, *E.C. Twisselmann 11182* (CAS). **Sonoma Co.:** near Kenwood, 18 Sep 1932, *J.T. Howell 10780* (CAS). **INDIANA. Howard Co.:** E of Kokomo, in dry cindery soil, 22 Jul 1941, *"Chas. M. Ek." s.n.* (NY). **IOWA. Marion Co.:** Knoxville Twp., wet clay adjacent to water in strip mine, 23 Jul 1957, *T.V. Bruggen s.n.* (DAO). **MAINE. Androscoggin Co.:** Valley of Androscoggin River, S of Polland, 1895, *K. Furbish s.n.* (GH). **Aroostook Co.:** Valley of Meduxnekeag River, roadside, 12 Aug 1909, *M.L. Fernald s.n.* (GH). **Cumberland Co.:** Brunswick, Sep 1891, *K. Furbish s.n.* (GH). **MASSACHUSETS. Hampshire Co.:** Ryan Road, Northampton, waste ground, gravel pit, 11 Aug 1978, *H.E. Ahles 86179* (QFA). **Middlesex Co.:** N of Wobum, 1951, *G.H. Hilton s.n.* (GH). **Worcester Co.:** S of Royalston, 1907, *J.A. Bates s.n.* (GH). **NEW YORK:** New York City, near Van Cortland Park, in sandy soil, 17 Jul 1891, *E.P. Bicknell s.n.* (NY). **Rhode Island. Providence Co.:** Elmwood, 30 Aug 1893, *J.F. Collins s.n.* (GH). **(SOUTH?) DAKOTA:** (Augustana?) College, 1889, *J.C. Zuffey s.n.* (US). **WEST VIRGINIA. Hardy Co.:** immediately E of Trout Run in cleared area leading to automatic Beacon Tower, 9 Aug 1941, *H.A. Allard 9389* (US).

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MASSIMO MAFFEI (ed.). 2002. **Vetiveria: The Genus *Vetiveria*.** (ISBN 0-415-27586-5, hbk.). **Medicinal and Aromatic Plants–Industrial Profiles. Volume 20**. Series Editor: Roland Hardman. Taylor & Francis, 11 New Fetter Lane, London EC4P 4EE, UK and 29 West 35th Street, New York, NY 10001, U.S.A. (Orders: info@tandf.co.uk, www.tandf.co.uk, 44 (0) 207 583 9855, fax 44 (0) 207-842-2298, standing orders call 44 (0)1264 343071. **US and Canada Customers:** By mail: Taylor & Francis Customer Service, 10650 Toebben Drive, Independence, KY 41051, U.S.A., Toll Free Tel: 1-800-634-7064, Toll Free Fax: 1-800-248-4724, email: cserve@routledge-ny.com). $96.00, 191 pp., numerous b/w photos, drawings and tables, one color photo, 7" × 10".

From Taylor & Francis website.—"The genus *Vetiveria* is one of the most versatile genera in plant species. The book describes the anatomy, physiology, biochemistry, essential oil biogenesis and chemical composition, ethnopharmacology and distillation, as well as the production of plants for oil exploration and for the use of *Vetiveria* as an ecological tool against erosion, flood, soil pollution and many other applications."

Contents.—**1)** Introduction to the Genus *Vetiveria*; **2)** Anatomy, Biochemistry and Physiology; **3)** Collection, Harvesting, Processing, Alternative Uses and Production of Essential Oil; **4)** Chemical Constituents and Essential Oil Biogenesis in *Vetiveria zizanioides*; **5)** Ethnopharmacology and Pharmacological Properties of *Vetiveria zizanioides*—Including Pharmacologic and Pharmacokinetic Properties; **6)** Vetiver Grass Technology; **7)** Biotechnology; **8)** Economic Importance, Market Trends and Industrial Needs, and Environmental Importance, **9)** Beyond the Vetiver Hedge –Organizing Vetiver's Next Steps to Global Acceptance, and Index.

UVULARIA (LILIACEAE) IN TEXAS

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ABSTRACT

This report documents the occurrence and distribution of the *Uvularia perfoliata* and *U. sessilifolia* in the state of Texas. A key to species, notes, distribution (including a map), and a list of exsiccatae are presented.

RESUMEN

Se cita y se documenta la presencia y distribución de *Uvularia perfoliata* y *U. sessilifolia* en el estado de Texas. Se presenta una clave de especies, notas, distribución (incluyendo un mapa), y una lista de exsicatas.

Uvularia is a small genus of five species native to eastern North America from Nova Scotia and southern Quebec south to Florida and westward to Texas and North Dakota (Wilbur 1963; Utech & Kawano 2002). The plants are rhizomatous perennial herbs with leafy, forked aerial stems. Leaves may be sessile or perfoliate. Plants normally have one or occasionally two greenish or yellow flowers that are campanulate in shape.

Our objectives are to document knowledge of the expanded distribution of *Uvularia sessilifolia* and *Uvularia perfoliata* in eastern Texas, summarize the known history of both species within Texas, and provide a means of identifying the species in the state. The paper is based upon recent field studies conducted in the eastern portion of the state and examination of herbarium specimens from selected herbaria (ASTC, BAYLU, & TEX).

KEY TO THE SPECIES OF *UVULARIA* IN TEXAS

1. Leaves rounded at the base, perfoliate _____ **1. U. perfoliata**
1. Leaves narrowed at base, sessile, not perfoliate _____ **2. U. sessilifolia**

1. Uvularia perfoliata L.

Uvularia perfoliata is distributed from New England and Ontario south and westward to Florida, Texas and Arkansas (Wilbur 1963, Utech & Kawano 2002). Within Texas, the species is known from Sabine, Nacogdoches, Shelby, and San

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Augustine Counties (Fig. 1), a distribution that is basically contiguous with the distribution in Louisiana presented by Thomas & Allen (1993). The species occurs in mixed beech-maple series hardwood forests.

Brown (1972) first mentioned the occurrence of *Uvularia pefoliata* in Texas but provided neither specific location nor other documentation. Brown made trips to rich woodlands in eastern Texas and was generally consistent about making vouchers for his photos, but he either failed to do so in the case of *U. perfoliata* or the collection was lost or destroyed (Mark Mayfield, pers. comm.). The first documented record of this species in the state was Nixon and Damuth's (1987) report for Sabine County. In 1989, Bridges and Orzell presented an account of the species in Texas, citing seven collections, all from Sabine County. Turner et al. (2003), in the *Atlas of Vascular Plants of Texas*, illustrate the distribution of the species as being Sabine, Shelby, and St. Augustine counties. The species is reported as occurring in Nacogdoches County for the first time.

In addition to distinctive perfoliate leaves, the species is characterized by short 1 cm long rhizomes, scarious smooth-margined leaves, and terete hollow aerial stems. In the following list of exsiccatae, only one specimen per county is cited

Specimens examined: **Nacogdoches Co.:** 6 mi ENE of Cushing, upper spring creek drainage that drains into Barnes Lake, Apr 1994, *Singhurst 4912a* (BAYLU). **Sabine Co.:** 4.1 mi E of Geneva, 22 Mar 1985, *Nixon 14347* (ASTC). **San Augustine Co.:** 0.7 air mi NW of Black Ankle, Sabine National Forest, Tenaha Ranger District, Compartment 65, 12 Apr 1989, *Orzell 9209* (TEX). **Shelby Co.:** 0.3 air mi ESE of FM 2261 and FS Rd 106 jct in E Hamilton, Sabine National Forest, Tenaha Ranger District, Compartment 50, 12 Apr 1989, *Orzell 9261* (TEX).

2. Uvularia sessilifolia L.

The distribution of *Uvularia sessilifolia* extends from southern Canada (Ontario and Nova Scotia), south to Florida and west to Texas, Oklahoma, and North Dakota (Wilbur 1963; Utech & Kawano 2002). *Uvularia sessilifolia* has been documented in three locations in Newton County and one location in Jasper County (Fig. 1), approximately 280 km from the Cass County location cited in this paper, and 210 km from its nearest Louisiana record in Lincoln Parish (Thomas & Allen, 1993). The species occurs in moist hardwood and bottomland forests, but in more xeric sites than *U. perfoliata*. The distribution map of this species in Flora of North America (Utech & Kawano 2002) shows it occurring in extreme northeast Texas, perhaps Bowie or possibly Lamar and Red River counties (the small scale of the map prevents accurate determination of county), which all border Oklahoma and the Red River. Examination of specimens from these counties determined to be *U. sessilifolia* showed them to be immature and sterile specimens of *Polygonatum biflorum* (Walt.) Elliott. (Liliaceae), a species that is uncommon and sporadic where it occurs in east Texas. The Cass County specimen cited is the only report of the species outside of the longleaf pine region of southeast Texas (Newton and Jasper counties).

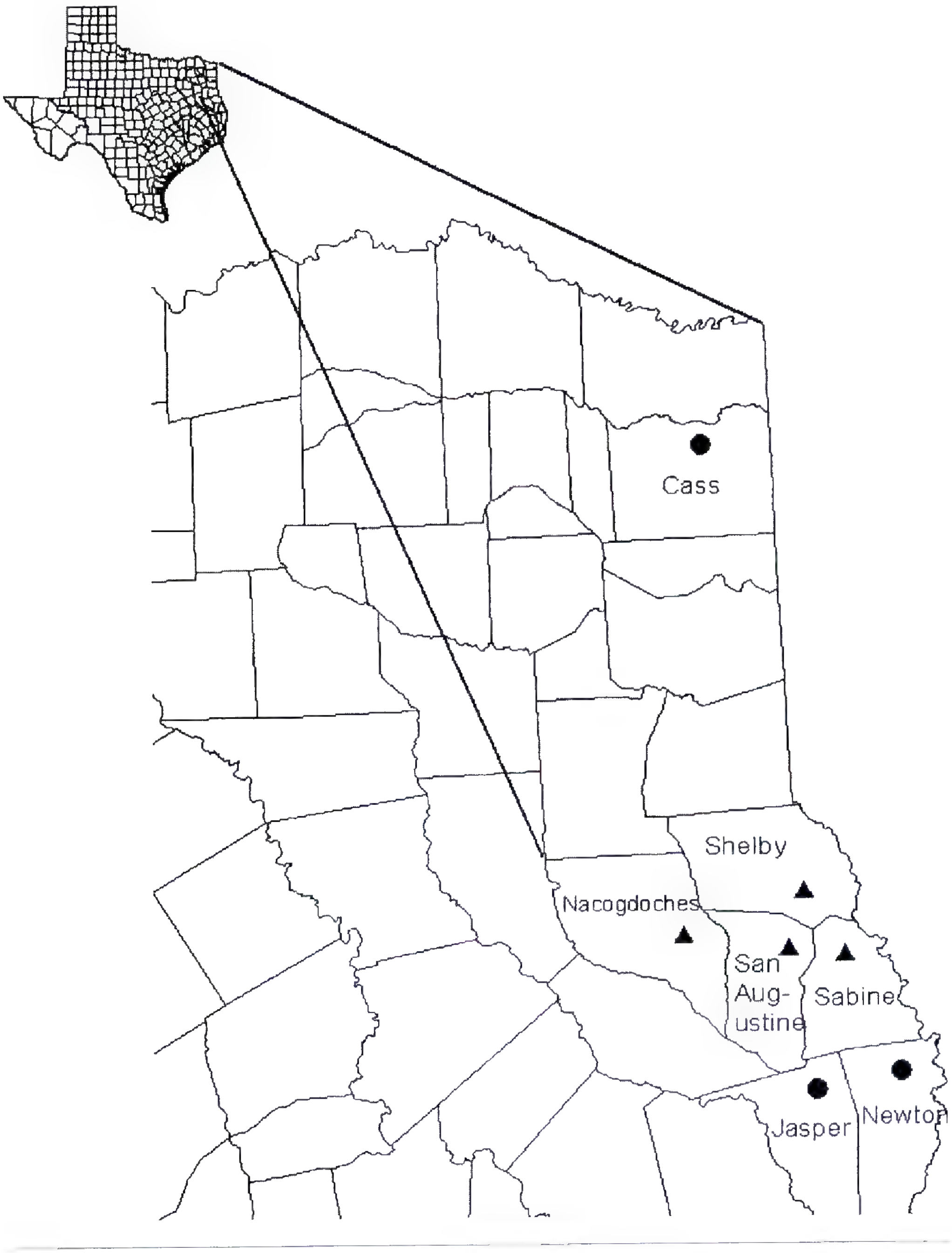


FIG. 1. Distribution of *Uvularia perfoliata* (triangles) and *U. sessilifolia* (circles) in Texas.

In addition to sessile non-perfoliate leaves, *Uvularia sessilifolia* can be distinguished from *U. perfoliata* by its longer rhizome of 10 cm or more in length, scarious margined leaves that are very finely serrulate, and aerial stems that are angled and solid. In the following citations of specimens, both the Cass county and Jasper County records are reported for the first time. Because of the

rarity of the species in the state, all collections are cited.

Specimens examined: **Cass Co.:** Atlanta State Recreational Area, base of Dogwood Trail at jct. of wood bridge, 9 Mar 2002, *Singhurst 11724* (BAYLU). **Jasper Co.:** Temple Inland Distinctive Site, Beef Creek, S of Rayburn Country, jct. of R255 and private forest road between Rayburn Country and Lake Sam Rayburn Dam, 1 mi S of forest road, 6 Mar 2002, *Singhurst 11213* (BAYLU). **Newton Co.:** Little Quicksand Creek on FM 1414 ca. 2.8 mi E of jct of Tex. Hwy 87 N of Newton, 3 Apr 1997, *Carr 15983* (TEX); Hickman Creek ca. 0.4 mi W of jct. with FM 645, 3 Apr 1998, *Singhurst 6591 & Watson* (BAYLU); Mack Creek, ca. 4 mi E of Newton on FM 1414, 4 Mar 2000, *Holmes 10795, Singhurst, & Caldwell* (BAYLU).

ACKNOWLEDGMENTS

We are grateful to Tom Wendt (TEX) for his assistance and Mark Mayfield (formerly of LSU, now of KSC) for information on the collections of Claire Brown We also acknowledge the cooperation of the United States Army Corps of Engineers for granting access to public lands near Lake Wright Patman in Bowie and Cass counties. Richard Carter (VSC) and Heather White (BAYLU) reviewed preliminary versions of the manuscript.

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FAGOPYRUM ESCULENTUM (POLYGONACEAE), NEW FOR TEXAS

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Collections of *Fagopyrum esculentum* Moench (*Polygonum fagopyrum* L.), buckwheat, were made in May and June of 2003 in the Lyndon B. Johnson National Grasslands near Decatur, Texas (Wise County). This native of Central Asia is reported for Oklahoma, New Mexico, and Louisiana by Kartesz (1999). Despite this proximity, it has not previously been reported for Texas (Correll & Johnston 1970; Stanford 1976; Hatch et al. 1990; Diggs et al. 1999). Since other populations of *F. esculentum* have not been found in North Central Texas, it is unknown if the species is more widely established.

The generic name *Fagopyrum* is derived from Latin "fagus," meaning beech, and "pyros," meaning wheat, because of the resemblance of the plant's seed to the beech-nut. The English name is derived from the German "buchweizen" (Fernald 1950) or a corruption of "boek-weit," the Dutch form of the word "buckwheat" (Grieve 1931).

Fagopyrum esculentum is one of a continuing procession of introduced species (i.e. those originating outside the United States) finding its way into the Texas flora (O'Kennon et al. 1999). Taxa such as *F. esculentum* are variously referred to as "alien," "exotic," or "foreign." In a recent floristic study of North Central Texas (Diggs et al. 1999), it was determined that 17.7% of the flora (394 species) consisted of introduced species.

Lyndon B. Johnson National Grasslands is comprised of numbered "units" scattered throughout much of north central Wise County. *Fagopyrum esculentum* was found in two widely separated units. At the collection site in Unit 71, two populations, approximately 300 meters apart with about twenty individuals at each site, were observed growing along a moist unpaved limestone road, in the roadbed and in the ditch along the road. Plants were young and about 12–18 cm tall. In Unit 3, 18 km west of Unit 71, about 100 plants were

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FIG. 1. *Fagopyrum esculentum*. Illustration by Jean Henri Jaume St.-Hilaire (1828–1832).

observed in a sandy open woodland. Individuals in this population were as tall as 25 cm.

Fagopyrum esculentum (Fig. 1) can be recognized by the following description (modified from Barkley 1986): annual erect herb, from a slender taproot, to 50 cm tall. Stem glabrous to pubescent at the nodes. Leaves long-petiolate be-

low, becoming sessile above, acuminate, the base broadly sagittate, cordate or truncate; stipules glabrous to puberulent, acute, sheathing but open on one side. Racemes axillary, single or in corybiform to paniculate groups, these 1 per leaf axil, long-pedunculate and usually exceeding the subtending leaf; bracts glabrous, ovate, acute; pedicels not jointed. Perianth white to creamy, streaked tan, 5-lobed, connate below, 3–4 mm long; stamens 8; styles 3, free. Achene strongly exserted, 3-angular, shiny, dark brown. (n = 8, 2n = 16) May–Sep(–Oct). Cultivated fields, disturbed places, waste ground; escaped in many parts of U.S. & the world; Asia. Introduced.

Curiously, the first record of *Fagopyrum* in Texas was found in a plant scrapbook created in 1925. This bound collection of pressed plants, notes, and illustrations was donated to BRIT at some time in the past, but the source is unknown. The plants were collected in Fort Worth, Texas, by M.J. Joyslin. Though a pressed specimen of *F. esculentum* and a fine watercolor of the subject were both preserved on one of the pages, they had been misidentified. As a result of awareness of the new Wise County collections, the scrapbook page was serendipitously recognized as the first, albeit unofficial, collection known from the state.

Voucher specimens: **TEXAS. Wise Co.:** along limestone roadway through Grand Prairie in Unit 71 of the Lyndon B. Johnson National Grasslands, N33° 18' 35", W097° 36' 35", 30 May 2003, *O'Kennon, McLemore, and Neill 18432* (BRIT). **Wise Co.:** sandy open forest of Western Cross Timbers in Unit 3 of the Lyndon B. Johnson National Grasslands, N33° 22' 30", W097° 46' 19", 5 Jun 2003, *O'Kennon and McLemore 18453* (BRIT).

ACKNOWLEDGMENT

Thanks to Guy Nesom of BRIT for assistance in identifying this plant.

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TRIGLOCHIN CONCINNA (JUNCAGINACEAE), A NEW FAMILY, GENUS, AND SPECIES FOR TEXAS

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Triglochin is a genus of about 20 species, most of these confined to aquatic habitats in the more temperate regions of the world (Thieret 1988). It has not previously been reported for Texas (cf. Haynes & Hellquist 2000; Turner et al. 2003), although at least two species of the genus have been collected in New Mexico (Correll & Correll 1972).

On July 26, 2003 a survey for plants along a saline aquatic habitat near Ruidosa (Presidio County), Texas revealed *Triglochin concinna* var. *debilis* (M.E. Jones) J.T. Howell (Fig. 1) growing along the embankment of a perennial sulfur stream. We have followed the taxonomy of Thorne (1993) in recording this taxon, although we are aware that Haynes and Hellquist (2000) position the latter in their broad concept of *T. maritima* L.

Voucher specimen: U.S.A. **TEXAS. Presidio Co.:** ca 2.2 mi NNW of Ruidosa growing along perennial sulphur streams and about tinajas. *M.W. Turner 99* (SRSC, TEX).

The species was noted to be relatively uncommon at the site, although at least four or five plants were noted along a path of about 40 meters. It was growing with a number of other rarely encountered semiaquatic species of the Trans-Pecos such as *Anemopsis californica*, *Samolus* sp., and *Eustoma exaltatum*.

The sampled site sits upon the property of Mr. James Blumberg of Ruidosa, Texas. We are grateful to him for permitting us entry to his property; indeed, he accompanied us on our impromptu visit, providing helpful comments on this or that collecting site.

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FIGS. 1–2. **1.** *Triglochin concinna*: photograph of voucher specimen from the property (Presidio County, Texas) of Mr. James Blumberg; **2.** Illustration from Bentham (1865), Handbook of the British Flora, fig. 964; illustrated as *T. maritimum*.

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ANDROPOGON GLOMERATUS VAR. *GLAUCOPSIS* (POACEAE: ANDROPOGONEAE) DOCUMENTED IN LOUISIANA

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ABSTRACT

Andropogon glomeratus (Walt.) B.S.P. var. *glaucopsis* (Elliott) Mohr is reported for Louisiana. A key to separate the Louisiana taxa in the *A. virginicus* complex is provided.

RESUMEN

Se cita *Andropogon glomeratus* (Walt.) B.S.P. var. *glaucopsis* (Elliott) Mohr de Louisiana. Se aporta una clave para separar los taxa del complejo *A. virginicus* en Louisiana.

The *Andropogon virginicus* complex comprises nine closely interrelated species (Campbell 1983). In Louisiana, the complex is represented by four of the nine species: *A. glomeratus* (Walt.) B.S.P., *A. gyrans* Ashe, *A. liebmannii* Hack, and *A. virginicus* L. The taxonomic difficulty of this complex is due to the strong similarity of its members, and the paucity and subtlety of the characters used to separate the taxa (Campbell 1983). A review of the literature reveals a difference of opinion in the recognition of the infraspecific taxa of the *A. virginicus* complex in Louisiana.

Campbell (1983) reported the following taxa as occurring in Louisiana: *Andropogon liebmannii* Hack. var. *pungensis* (Ashe) C.S. Campb., *A. glomeratus* (Walt.) B.S.P. var. *pumilus* (Vasey) Vasey ex L.H. Dewey, *A. gyrans* Ashe var. *gyrans* and var. *stenophyllus* (Hack.) C.S. Campb., and *A. virginicus* L. var. *virginicus* and var. *glaucus* Hack. Thomas and Allen (1993) reported *A. glomeratus* var. *glomeratus*, *A. gyrans* var. *gyrans*, *A. liebmannii* var. *pungensis*, and *A. virginicus* in Louisiana, and listed *A. glomeratus* (Walt.) B.S.P. var. *glaucopsis* (Elliott) Mohr as an undocumented sight record from St. Tammany Parish. Allen (1992) recognized *A. liebmannii*, *A. glomeratus*, *A. gyrans*, and *A. virginicus* as occurring in Louisiana, but did not recognize any infraspecific taxa.

Fieldwork in southeastern Louisiana has resulted in the collection of *Andropogon glomeratus* (Walt.) B.S.P. var. *glaucopsis* (Elliott) Mohr from St. Tammy Parish.

Andropogon glomeratus (Walt.) B.S.P. var. **glaucopsis** (Elliott) Mohr, Bull. Torrey

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Bot. Club 24:21. 1897. [= *A. glaucus* Muhl., *A. capillipes* Nash, *Cympogon glaucua* Schult.] LOUISIANA. ST. TAMMANY PARISH: N of Bayou Paquet Road, 0.3 mi E of its intersection with Transmitter Road, along fire-line that follows refuge boundary W of dirt road, 26 Oct 2001, *Rosen & Jones 1664* (BRCH-Oregon, NO).

Keys to separate the taxa modified from Campbell (1983) and Allen (1992) follow. See Campbell (1983) for a list of representative specimens from Louisiana. The classification of taxa in the *Andropogon virginicus* complex provided here-with follows that of Campbell (2003).

KEY TO THE LOUISIANA TAXA IN THE *ANDROPOGON VIRGINICUS* COMPLEX

1. Racemes (2–)4–6(–13) terminating each peduncle; sheaths villous _____ **A. liebmannii** var. **pungensis**

1. Racemes 2(–3) terminating each peduncle; sheaths glabrous to villous.
   2. Plants usually less than 1 m tall; leaves usually less than 3 mm wide; raceme sheaths inflated, usually more than 4.6 cm long _____ **A. gyrans**
   2. Plants larger, usually 1 m or more tall; leaves usually more than 3 mm wide; raceme sheaths usually less than 4.6 cm long.
      3. Blades usually more than 37 cm long; stem sheaths often scabrous; ligules usually more than 1 mm long (if less than 1 mm long the keels of the first glume often scabrous below the middle) _____ **A. glomeratus**
      3. Blades usually less than 31 cm long; stem sheaths smooth (rarely somewhat scabrous); ligules less than 1 mm long; keels of the first glume scabrous only above the middle _____ **A. virginicus**

KEY TO THE VARIETIES OF *ANDROPOGON GYRANS* IN LOUISIANA

1. Ligules usually less than 0.8 mm long; plants of well-drained sites _____ **A. gyrans** var. **gyrans**
1. Ligules (0.8–)1.1(–1.5) mm long; plants of wet sites _____ **A. gyrans** var. **stenophyllus**

KEY TO THE VARIETIES OF *ANDROPOGON GLOMERATUS* IN LOUISIANA

1. Leaves and culms conspicuously glaucous _____ **A. glomeratus** var. **glaucopsis**
1. Leaves and culms green.
   2. Keels of first glume scabrous below the middle; plants (0.2–)1.4(–2.5) m tall _____ **A. glomeratus** var. **pumilus**
   2. Keels of first glume scabrous above the middle only; plants (0.6–)1.0(–1.6) m tall _____ **A. glomeratus** var. **glomeratus** (expected in Louisiana)

KEY TO THE VARIETIES OF *ANDROPOGON VIRGINICUS* IN LOUISIANA

1. Leaves and culms conspicuously glaucous _____ **A. virginicus** var. **glaucus**
1. Leaves and culms green _____ **A. virginicus** var. **virginicus**

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CAREX CONOIDEA (CYPERACEAE) NEW TO ARKANSAS AND NOTES ON ITS OCCURRENCE IN ARKANSAS AND MISSOURI

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The range of *Carex conoidea* Schkuhr ex Willd. extends from Newfoundland and Nova Scotia west to Manitoba and south to Missouri, Illinois, Indiana, Ohio, and North Carolina; disjunct and possibly introduced in Arizona (Radford et al. 1964; Mohlenbrock 1999; Yatskievych 1999; Naczi & Bryson 2002). Habitat listed for the species includes "bogs," "low ground, and moist grassy places," "wet meadows, wet prairies," and moist depressions of upland prairies (Radford et al. 1964; Voss 1972; Mohlenbrock 1999; Yatskievych 1999; Naczi & Bryson 2002). The species has not been previously documented from Arkansas (Hyatt 1998; Smith 1988; Arkansas Vascular Flora Committee 2002; Naczi & Bryson 2002).

On 8 May 2003, while conducting a plant survey on Searles Prairie Natural Area in Benton County, Arkansas, we discovered 32 clumps of *Carex conoidea* scattered throughout the western half of the preserve. The species is readily recognized by the combination of light green leaves, scabrous peduncles and culms below the inflorescence, bracts that subtend the uppermost pistillate spikes equaling or exceeding the staminate spike, and its plump, lustrous green perigynia with ca. 20 impressed nerves. *Carex conoidea* can be readily distinguished from other members of the *Carex* section Griseae (L.H. Bailey) Kükenthal in Arkansas by the combination of its scabrous peduncles and culms below the inflorescence, the fewer number of impressed nerves (others in the Section usually have 40 or more nerves), and the position of the staminate spike, well-exserted above the uppermost pistillate spike.

Various authors (e.g., Steyermark 1963; Mohlenbrock 1999; Yatskievych 1999) depict the perigynia of *C. conoidea* as being tapered at both ends. Illustrators undoubtedly only had access to herbarium specimens or over-mature

perigynia, as fresh, mature perigynia of *C. conoidea* are plump and inflated, and watermelon shaped. We have noticed the perigynia of *C. conoidea* shrink and become tapered at both ends upon drying in a plant press.

Clumps of *Carex conoidea* at the Searles Prairie site extend from swales in the prairie to the drier margins of areas just upslope of the depressions. Despite the field characters listed above, identification of *C. conoidea* in the field can be difficult because many of the tufts may have few flowering culms and the culms often lean on or are hidden by adjacent, taller vegetation.

Searles Prairie represents the last intact remnant of the Osage Prairies that once surrounded the town of Rogers, Arkansas in Benton County. It was used as a hay meadow and cut annually until it was donated to the Arkansas Natural Heritage Commission in 1988. Prescribed fire was introduced to the prairie in 1996, with additional prescribed burns in December 2001 and February 2003. Searles Prairie is a low loamy prairie that probably exists because of shallow, impervious clay subsoil and fluctuations in water depth and persistence. This provides graminoids and other ground-covering forbs a competitive advantage over trees (Arkansas Natural Heritage Commission 2002). The Jay and Cherokee silt loam soils are characterized by layers of moderately well-drained silt loam, to somewhat poorly drained silt loam, silty clay loam, and clay. This prairie remains wet for long periods of time after rains due to the clay (United States Department of Agriculture 1977) and poor drainage.

Plants associated with *C. conoidea* at Searles Prairie include *Agrostis hyemalis, Andropogon gerardii, Carex brevior, C. bushii, C. buxbaumii, C. festucacea, Cephalanthus occidentalis, Cicuta maculata, Eleocharis verrucosa, E. wolfii, Eryngium yuccifolium, Eupatorium perfoliatum, Galium obtusum, Juncus spp., Orbexilum pedunculatum, Panicum acuminatum, P. scoparium, Physostegia angustifolia, Potentilla simplex, Pycnanthemum tenuifolium, Ranunculus laxicaulis, Rubus spp*, and *Sisyrinchium angustifolium.*

Voucher Specimens: U.S.A. **ARKANSAS. Benton Co.:** Searles Prairie Natural Area; inter. of U.S. Rt. 62 and Dixieland Rd. in Rogers, AR; T20NR30WS35SE1/4SE1/4SW1/4; Bentonville South 7.5' Quad. 8 May 2003, *McKenzie 2081* (DOV, MO); *Witsell 03-0232* (anhc-Arkansas Natural Heritage Commission, LRU); & 11 Jun 2003 *Witsell 03-0474* (anhc-Arkansas Natural Heritage Commission, APCR, LRU, peh-pers. herb. of Philip E. Hyatt, STAR, UARK).

Carex conoidea is apparently a good indicator of high quality, well-managed prairies in Missouri as well as Searles Prairie in Arkansas (Yatskievych 1999; pers. obs.). The lack of records in some prairies may reflect the lack of survey efforts by individuals familiar with the species' field characters or the difficulty in seeing the diagnostic inflorescences among other prairie vegetation. Searches for the species by the senior author in five prairies in Benton and Pettis counties, Missouri in early June 2002 failed to yield additional populations. Searches in two additional Arkansas prairies by the authors on 9 May 2003 and five

additional sites by Witsell in Arkansas in May and June 2003 failed to document the species at additional localities. Subsequently, however, McKenzie and Smith discovered the species at Hite Prairie in Morgan County and Taberville Prairie in St. Clair County, Missouri on 6 and 7 June, 2003, respectively [*McKenzie 2085* (DOV, MO), *2090* (DOV, MO)]. These collections represent only the third and fourth extant records of this sedge in Missouri. The plants were difficult to see at the two Missouri sites, however, because the 20 and 30 clumps with few flowering culms had inflorescences leaning on or hidden among adjacent, taller vegetation. Despite the limitations mentioned above, future searches for *C. conoidea* should be conducted in other high quality prairies throughout Arkansas and Missouri from about 1 May to 1 June depending on the latitude of the locality to be surveyed.

Botanical nomenclature listed herein follows Yatskievych (1999) or Yatskievych and Turner (1990).

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ADDITIONS TO THE FLORA OF CLEVELAND COUNTY, ARKANSAS: COLLECTIONS FROM MORO BOTTOMS NATURAL AREA, A STATE-PROTECTED OLD-GROWTH BOTTOMLAND HARDWOOD FOREST

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ABSTRACT

An annotated list of 38 additions to the vascular flora of Cleveland County, Arkansas is presented. The additions presented were collected from Moro Bottoms Natural Area, a state-protected old-growth bottomland hardwood forest located in the northwest region of the county.

RESUMEN

Se presenta una lista comentada de 38 adiciones a la flora vascular de Cleveland County, Arkansas. Las adiciones presentadas se recolectaron en Moro Bottoms Natural Area, un bosque pantanoso viejo protegido por el estado, ubicado en la parte noroeste del municipio.

This paper reports 38 additions to the vascular flora of Cleveland County, Arkansas. Collections were taken from windthrow gaps[2] areas within Moro Bottoms Natural Area, a 40 ha old growth bottomland hardwood forest located in the northwestern portion of Cleveland County. The area rests on the floodplain of Moro Creek, a tributary of the Ouachita River, approximately 48 km/30 mi upstream from the mouth of Moro Creek (Peacock 1983). Moro Bottoms supports a diverse stream-bottom community dominated by numerous bottomland oaks (*Quercus spp.*), sweetgum (*Liquidambar styraciflua* L.), bald cypress (*Taxodium distichum* (L.) Richard), and several hickories (*Carya* spp.). The study area and most of Cleveland County reside in the west gulf coastal plain physiographic region of Arkansas. Moro Bottoms is an excellent example of a mature stream-bottom forest becoming old growth through gap regeneration (Devall et al. 2001). The stand contains many old growth features, including little to no

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[2]A severe thunderstorm swept across the Moro Bottoms tract during the summer of 1989, downing trees and creating large openings in the forest canopy commonly referred to as windthrow gaps.

evidence of human-induced disturbance and numerous large diameter trees. Devall et al. (2001) reported cherrybark oak (*Quercus pagoda* Raf.) and sweetgum to have diameters at breast height up to 149 cm/59 in. Additionally, a sample of larger red oaks and white oaks were determined to be approximately 150 years and 250 years of age, respectively (Guldin et al. 1995). Presently Moro Bottoms and adjacent areas are owned and protected by the Arkansas Natural Heritage Commission and the Arkansas Nature Conservancy. The land was purchased from Georgia Pacific Corporation in 1986.

Collecting of specimens was initiated in the spring of 1990 and continued seasonally through the fall of 1992. A more detailed description of sampling methods is discussed in Devall et al. (2001). Collecting efforts and identifications were performed by the authors; some material presented includes collections made by E. Sundell. Specimens are housed in the herbarium collection at the U.S. Forest Service, Southern Hardwoods Laboratory [SHL] (432 Stoneville Road, Stoneville, MS 38776), with some duplicates and voucher material deposited in the University of Arkansas-Monticello Herbarium [UAM]. Smith (1988) and The PLANTS Database (USDA Natural Resources Conservation Service 2002) were consulted to verify the undocumented occurrence of species within Cleveland County we present.

The following annotated list is arranged alphabetically by family, and then by genus and species. Generalized species and habitat descriptions, supplemental to the description of the study area discussed above, cite Radford et al. (1968) and Godfrey and Wooten (1979 and 1981); range data within the state of Arkansas are taken from Smith's (1988) *Atlas*. Collector, number and herbaria of deposit are listed last. Accession numbers are given for those specimens housed in the SHL herbarium.

ARISTOLOCHIACEAE

Aristolochia serpentaria L.—Small herb of bottomland forests and woodland margins; Smith (1988) reports this species for 24 Arkansas counties, mostly in the western haif of the state, it is however listed for neighboring Bradley and Drew counties in southeastern Arkansas; *Sundell* 9136 (UAM).

ASCLEPIADACEAE

Asclepias perennis Walter—A common herb of alluvial forest, usually in low lying areas on heavy clays; reported in Smith (1988) for most eastern counties bordering the Mississippi River and inland into the coastal plain region of the state; present in neighboring Bradley, Dallas, Drew and Lincoln counties; *Devall s.n.* (SHL: 710).

ASTERACEAE

Brickellia eupatorioides (L.) Shinners—Disturbed woodland sites and thickets; a suprising find for Cleveland County, listed by Smith (1988) in western Arkansas counties of quite different physiography than the coastal plain soils of Cleveland County; *Devall s.n.* (SHL: 758).

Eupatorium hyssopifolium L.—A weedy plant of woodland borders and openings, probably seeded in from adjacent upland mixed pine-hardwood stands where it would be more common; only reported by Smith (1988) in four Arkansas counties: Jefferson, Lincoln, Bradley, and Calhoun; *Deval s.n.* (SHL: 738).

Mikania scandens (L.) Willd.—A perennial climbing vine usually associated with disturbed areas and margins of stream-bottom forests,

wet woods; Widespread across southern Arkansas and up the Mississippi River border counties (Smith 1988); *Devall s.n.* (SHL: 718), *Sundell* 9129 (UAM).

CALLITRICHACEAE

Callitriche heterophylla Pursh—Aquatic herb of ditches, shallow depressions, and standing water; widespread, occurring in several Arkansas counties including neighboring Bradley and Drew counties; *Devall s.n.* (SHL:933).

CORNACEAE

Cornus stricta Lam.—Small understory tree of bottomland hardwood forests, usually occurring on heavier textured soils than other dogwoods found in the bottoms; listed in Smith (1988) as *C. foemina*, this species is found in most Arkansas counties, excluding those in the Ozarks, also reported for all counties contiguous to Cleveland County; *Devall s.n.* (SHL: 704, 745).

CRASSULACEAE

Penthorum sedoides L.—Rhizomatous herb common to wet depressional areas, ditches and slough margins, heavy clay soils; widespread, found in several Arkansas counties, including neighboring Drew, Bradley, Calhoun, Dallas, Grant, and Jefferson counties (Smith 1988); *Devall s.n.* (SHL: 703, 711), *Sundell* 9142 (UAM).

EUPHORBIACEAE

Acalypha virginica L.—Weedy annual of disturbed sites and openings, common; found in almost every county in the state (Smith 1988); *Devall s.n.* (SHL: 767).

FABACEAE

Desmodium paniculatum (L.) DC. var. *dillenii* (Darl.) Isley—Woodland margins and openings; Smith (1988) reports this species for several Arkansas counties north and west of Cleveland County, but is reported for neighboring Bradley and Drew counties; *Sundell* 9134 (UAM).

Dioclea multiflora (Torrey & A. Gray) Mohr—Herbaceous vine common in disturbed woodland openings, alluvial forests; reported in 15 Arkansas counties by Smith (1988), mostly in the eastern and southern regions of the state; *Devall s.n.* (SHL: 748), *Sundell* 9140 (UAM).

HYDROPHYLLACEAE

Hydrolea uniflora Raf.—Somewhat decumbent herb of wet ditches, swampy areas, and wet woods; Smith (1988) reports this species for several southern and central Arkansas counties, including neighboring Bradley, Drew, Calhoun, and Jefferson counties; *Devall s.n.* (SHL: 746,747).

HYPERICACEAE

Hypericum walteri J.G. Gmel.—Perennial herb of wet floodplain forests, often associated with cypress swamps and bogs; this species is reported in 15 Arkansas counties, mostly in the southern portion of the state; reported for neighboring Bradley, Dallas, and Jefferson counties (Smith 1988); *Sundell* 9144 (UAM).

LAMIACEAE

Lycopus virginicus L.—Stoloniferous, running herb of bottomland forests, shaded ditchbanks and wet areas; Smith (1988) reports this species in several central counties across the state, as well as neighboring Jefferson, Lincoln, Drew, and Calhoun counties; *Devall s.n.* (SHL: 765).

ONAGRACEAE

Ludwigia palustris (L.) Ell.—Mat forming perennial common to swampy forests, pond margins, and exposed shallow depressions, somewhat invasive; scattered across the state in numerous counties; reported for neighboring Bradley and Drew counties (Smith 1988); *Devall s.n.* (SHL:709).

POLYGONACEAE

Brunnichia cirrhosa Banks ex Gaertn.—Invasive woody vine of woodland openings, margins, and disturbed sites; widespread across the state, with exception to the northwest counties of the Ozarks; Smith (1988) reports this species for all counties contiguous to Cleveland County; *Devall s.n.* (SHL: 754).

RUBIACEAE

Oldenlandia boscii (DC.) Chapm.—Nearly prostrate perennial with linear, opposite leaves; alluvial forests, shallow depressions; very lim-

ited range in Arkansas, only reported for 13 counties in Smith's (1988) *Atlas*, including neighboring Bradley, Drew, and Dallas counties; *Devall s.n.* (SHL: 698).

SAXIFRAGACEAE

Itea virginica L.—Deciduous shrub of bottom land forests, particularly on minor bottom sites away from the Mississippi floodplain forests in the eastern part of the state; widely distributed across the state except in the upland counties of the northwest and those counties bordering the Mississippi River (Smith 1988); *Devall s.n.* (SHL: 755).

SCROPHULARIACEAE

Lindernia dubia (L.) Pennell —Annual herb found along ditch edges and muddy flats border ing waterways, bottomland forests and openings; occurring in almost every county in the state, including neighboring Drew, Bradley, Calhoun, Dallas, and Jefferson coun ties (Smith 1988); *Devall s.n.* (SHL: 735), *Sundell* 9131, 9143 (UAM).

SOLANACEAE

Physalis pubescens L.—Weedy annual found in openings and disturbed sites; Smith's (1988) *Atlas* depicts a sporadic distribution across the state, but comments on its probable occurrence in all Arkansas counties; reported for neighboring Bradley county to the south; *Sundell* 9138 (UAM).

URTICACEAE

Boehmeria cylindrica (L.) Swartz—Very common woodland herb of bottomland hardwood forests, shaded ditches and woodland-edge ecotones; found in nearly every Arkansas county, including neighboring Jefferson, Lin coln, Drew, Bradley, and Dallas counties (Smith 1988); *Devall s.n.* (SHL: 705, 706).

VITACEAE

Vitis cinerea Engelm. ex. Millardet—Common woody vine of disturbed woodland sites and openings; leaves densely pubescent, some what aggressive in habit, restricted mostly to floodplain forest settings; Smith (1988) reports this species in several Arkansas counties across all physiographic regions of the state, including neighboring Jefferson, Lincoln, Drew, Bradley, and Dallas counties; *Devall s.n.* (SHL: 757).

Vitis palmata Vahl—Climbing woody vine with glabrous leaves, common to bottomland forests and disturbed woodland openings; distribution in Arkansas appears limited, re ported by Smith (1988) in 14 counties and for several other counties without vouchered material, mostly in the Mississippi River floodplain, the coastal plain, and Arkansas River valley counties; *Devall s.n.* (SHL: 756).

CYPERACEAE

Carex caroliniana Schwein.—Cespitose perennial of floodplain forests and wet meadows and openings; perigynia somewhat inflated and round, tightly arranged in a compact spike, spikes usually 3; range restricted in Arkansas to 8 central and southern counties with unvouchered reports for several other eastern counties (Smith 1988); *Devall s.n.* (SHL: 751,752).

Carex debilis Michx.—Cespitose sedge of low land woods, seepage areas and wet clearings; pistillate spikes loosely flowered (3-4), perigynia lanceolate tapering gradually to a beak; Smith (1988) reports this species in 13 counties mostly in the coastal plain counties of southern Arkansas including neighboring Grant, Jefferson, Lincoln, Drew, and Bradley counties; *Devall s.n.* (SHL: 729,730,731).

Carex festucacea Schkuhr ex Willd.—Tufted perennial of bottomland hardwood forests and wet openings; little documentation of this species in Arkansas, Smith's (1988) *Atlas* reports only 2 counties where vouchered material has been presented; our record is among the first reports for this species presence in the southeastern region of the state; *Devall s.n.* (SHL: 732).

Carex intumescens Rudge—Tufted perennial of alluvial forests, similar to the rhizomatus *C. louisianica*; pistillate spikes somewhat glo bose, loosely flowered, perigynia inflated gradually tapering to a beak; this species is well distributed across the southern half of the state, Smith (1988) reports this species in neighboring Lincoln, Drew, Bradley, and Dallas counties; *Devall s.n.* (SHL: 713).

Carex reniformis (Bailey) Small—Cespitose perennial common to alluvial forests and wet openings; pistillate spikes many flowered, ovoid, often tightly arranged terminally, perigynia orbicular, relatively flat, conspicuously winged; reported in Smith's (1988) *Atlas* for 10 Arkansas counties mostly in the southern half of the state including neighboring Drew, Bradley, and Calhoun counties; *Devall s.n.* (SHL: 766).

Carex tribuloides Wahlenb.—Abundantly common sedge of bottomland hardwood forests and low lying wet areas; pistillate spikes ovoid to obovoid, tightly arranged terminally, perigynia flat, narrowly ovate, winged apically; reported by Smith (1988) in 18 Arkansas counties mostly in the southern half of the state including neighboring Jefferson, Bradley, and Dallas counties. No doubt this species is present in all coastal plain and alluvial regions of the state; *Devall s.n.* (SHL: 739, 740, 741).

Carex typhina Michx.—Cespitose perennial found in alluvial woodlands; pistillate spikes erect, cylindrical, perigynia ovoid abruptly tapering to a short slender beak; this species is not well documented in Arkansas, reported by Smith (1988) in only 8 counties widely dispersed across the state; *Devall s.n.* (SHL: 762, 763).

JUNCACEAE

Juncus coriaceus Mack.—Clumping, cespitose rush with inflorescence appearing lateral, common to swampy woods and depressions; this rush has a fairly limited range in Arkansas, reported by Smith (1988) in 11 counties all situated within the Ouachita mountains and coastal plain physiographic provinces of the state; *Devall s.n.* (SHL: 708).

POACEAE

Agrostis perennans (Walter) Tuck.—Tufted perennial grass of alluvial forests and wet clearings; Smith (1988) reports this species in several counties dispersed across the state including neighboring Jefferson and Bradley counties; *Sundell* 9126 (UAM).

Cinna arundinacea L.—Rhizomatous perennial grass found in floodplain forests and on wet ditch banks; sporadic distribution across Arkansas, this species is found in 16 counties but with no discernable pattern depicting its range in the state. Smith (1988) reports this species for Bradley County to the south; *Sundell* 9145 (UAM).

Erianthus strictus Baldwin—Robust grass associated with swamp margins and ditches; spikelets conspicuously appressed; reported in Smith's (1988) *Atlas* in several southern Arkansas counties including Drew, Bradley, and Calhoun counties to the south; *Devall s.n.* (SHL: 742).

Leersia lenticularis Michx.—An often decumbent grass with distinctive lenticular florets arranged loosely in an open panicle; this species is associated with bottomland hardwood forests and other shaded swampy settings; appears to be undocumented for several Arkansas counties where it probably exists. Smith (1988) reports this plant in 12 counties mostly in the southern Mississippi River floodplain and coastal plain provinces of the state including neighboring Drew and Bradley counties; *Devall s.n.* (SHL: 749), *Sundell* 9125 (UAM).

Leersia virginica Willd.—Slender, freely branching perennial grass common to alluvial woodlands and swamps; this species is reported by Smith (1988) in several Arkansas counties, primarily in the northern half of the state, but is also documented in a few southern counties as well, including neighboring Drew and Bradley counties; *Sundell* 9124 (UAM).

Panicum dichotomum L.—Tufted perennial grass common to bottomland forests and wet clearings; Smith (1988) reports this plant essentially throughout the state, documented in neighboring Jefferson, Lincoln, Drew, Bradley, Dallas, and Grant counties; no doubt this species is present in Cleveland County; *Devall s.n.* (SHL: 715).

Panicum rigidulum Nees—Abundantly common grass of floodplain forests and wet depressions; this species has a wide distribution, occurring in all physiographic regions of the state, reported in Smith's (1988) *Atlas* for neighboring Jefferson, Lincoln, Drew, Bradley, and Grant counties; *Devall s.n.* (SHL: 770, 771).

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ARKANSAS FLORA: ADDITIONS, REINSTATEMENTS, EXCLUSIONS, AND RE-EXCLUSIONS

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ABSTRACT

Nine species are reported as new to the flora of Arkansas: *Agalinis nuttallii* Shinners (Scrophulariaceae), *Azolla caroliniana* Willd. (Azollaceae), *Crataegus thermopegaea* Palmer (Rosaceae), *Cyrtomium falcatum* (L.f.) K. Presl (Dryopteridaceae), *Nerium oleander* L. (Apocynaceae), *Polygala alba* Nutt. (Polygalaceae), *Punica granatum* L. (Punicaceae), *Ricinus communis* L. (Euphorbiaceae), and *Schinus terebinthifolius* Raddi (Anacardiaceae). They are a mixture of extinct, overlooked, or urban exotic-escaped species, some of which are of special concern as they pose new problems for urban poison control workers. Literature and herbarium work uncovered that 12 Arkansas species previously excluded actually have known and valid vouchers, and they are re-instated: *Acacia farnesiana* (L.) Willd. (Mimosaceae), *Arabis glabra* (L.) Bernh. (Brassicaceae), *Canavalia ensiformis* (L.) DC. (Fabaceae), *Cladium jamaicense* Crantz (Cyperaceae), *Eragrostis trichodes* (Nutt.) Wood (Poaceae), *Halesia diptera* Ellis (Styracaceae), *Lygodesmia juncea* (Pursh) D. Don (Asteraceae), *Prosopis glandulosa* Torr. var. *glandulosa* (Mimosaceae), *Rhynchospora colorata* (L.) Pfeiffer (Cyperaceae), *Rosa canina* L. (Rosaceae), *Sagina procumbens* L. (Caryophyllaceae), and *Trifolium stoloniferum* Muhl. (Fabaceae). Another 13 species previously excluded and/or re-excluded from Arkansas were recently and erroneously re-instated, requiring re exclusion. Another 76 species are here excluded, being reported erroneously as being from Arkansas, based either on literature reports that lack supporting voucher specimens or on a variety of clerical errors. These 21 additions and 89 subtractions to the Arkansas flora point to problems in achieving a uniform basis of deciding which plants to include in a flora and what constitutes sufficient documentation for known and valid vouchers.

RESUMEN

Se citan nueve especies nuevas para la flora de Arkansas: *Agalinis nuttallii* Shinners (Scrophulariaceae), *Azolla caroliniana* Willd. (Azollaceae), *Crataegus thermopegaea* Palmer (Rosaceae), *Cyrtomium falcatum* (L.f.) K. Presl (Dryopteridaceae), *Nerium oleander* L. (Apocynaceae), *Polygala alba* Nutt. (Polygalaceae), *Punica granatum* L. (Punicaceae), *Ricinus communis* L. (Euphorbiaceae), y *Schinus terebinthifolius* Raddi (Anacardiaceae). Son una mezcla de extintas, pasadas por alto, o especies urbanas exóticas-escapadas, alguna de las cuales son de especial interés ya que causan nuevos problemas a los trabajadores del control de venenos urbanos. Con el trabajo bibliográfico y de herbario se descubrió que 12 especies de Arkansas previamente excluidas tienen actualmente testigos conocidos y válidos, y son re-instauradas: *Acacia farnesiana* (L.) Willd. (Mimosaceae), *Arabis glabra* (L.) Bernh. (Brassicaceae), *Canavalia ensiformis* (L.) DC. (Fabaceae), *Cladium jamaicense* Crantz (Cyperaceae), *Eragrostis trichodes* (Nutt.) Wood (Poaceae), *Halesia diptera* Ellis (Styracaceae), *Lygodesmia juncea* (Pursh) D. Don (Asteraceae), *Prosopis glandulosa* Torr. var. *glandulosa* (Mimosaceae), *Rhynchospora colorata* (L.) Pfeiffer (Cyperaceae), *Rosa canina* L. (Rosaceae), *Sagina procumbens* L. (Caryophyllaceae), y *Trifolium stoloniferum* Muhl. (Fabaceae). Otras 13 especies excluidas previamente y/o re-excluidas

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de Arkansas fueron reciente y erróneamente re-instauradas, y necesitan una re-exclusión. Otras 76 especies se excluyen aquí, por haberse citado erróneamente de Arkansas, basadas tanto en citas bibliográficas que carecen de pliegos testigo o en varios errores administrativos. Estas 21 adiciones y 89 substracciones a la flora de Arkansas apuntan los problemas de poner a punto una base uniforme para decidir que plantas incluir en una flora, y que constituye suficiente documentación para los pliegos testigo conocidos y válidos.

The preparation of a state flora remains the grandest state scientific enterprise in most states. More than 1200 articles by nearly 100 botanists documented and explained the diversity, abundance, and distribution of its flora and vegetation (Peck & Peck 1988; Peck et al. 2000). Vascular plant floristics in Arkansas commenced with the 1819 exploratory travels, collections, and published list by Thomas Nuttall (1835). Earlier expeditions commented on plants, but appeared to either not have vouchers or none have survived from Arkansas locations (Palmer 1927, Morton 1967, MacRoberts et al. 1997). Subsequent flora lists were prepared by Lesquereux (1860) of 1320 species and by Branner and Coville (1891) of 1534 species, but were developed from limited field work and were poorly supported with extant vouchers. Buchholz and Palmer (1926) attempted to verify, locate vouchers, or re-collect many old Arkansas records, and in the process, added 534 species for a total of 2068. Demaree (1943) compiled all past lists, personally added 694 species, and presented a total list of 2723 species. As stated by Demaree (1943), many species on his list were not his records, but were compiled at face value from prior lists. Demaree (1943) knew some were of dubious identity, probably lacked vouchers, and contained records from Oklahoma when it was part of the "Arkansas Territory" from 1819–1836. But there was a war going on, no resources could be spared to validate the list, and the fate of species-level biology in Arkansas was in doubt.

Edwin B. Smith inherited the Arkansas state flora enterprise. Through near heroic efforts, being the last to attempt a "one man band" approach to a state flora, he produced two annotated checklists with county maps. Smith (1978) provided an annotated checklist with county dot maps for 2338 species, a list of 200 possible additions, a list of 365 excluded species (many old reports appeared to lack vouchers of any kind), and state maps with 40,941 county dots. Smith (1988) presented a revised list and maps for 2469 species, 324 possible additions, 375 excluded species, and maps with 49,510 county dots.

In 1998, a consortium of 16 botanists formed the Arkansas Vascular Flora Committee to prepare a checklist, database, atlas, and manual. To date, the Arkansas Vascular Flora Committee has located and verified vouchers for over 3350 taxa. Based upon the immensely helpful national electronic lists (Kartesz 1998, Kartesz & Meacham 1999; NRCS 1999), near monographic state floras from adjacent Missouri and Texas, the atlas and manual of the Flora of the Great Plains, checklists and atlases of Louisiana, Tennessee, and Texas, and the serial

volumes of the Flora North America project (Flora North American Editorial Committee 1993+), another 80 taxa might yet be added.

Through herbarium search and review of literature and national electronic floras, 110 noteworthy Arkansas species were identified that required addition (9), reinstatement (12), re-exclusion (13), or exclusion (76). The nine additions included overlooked but long-standing elements of the Arkansas flora and recent escapes with properties of ecological concern (invasive) or human concern (toxic). Twelve re-instated species included previously excluded, extinct, or extirpated species that required re-instatement as their vouchers were finally located, were replaced, or were erroneously excluded [criteria and judgment differs with differing workers]. Thirteen species were re-excluded that were erroneously reported and re-reported as present in Arkansas. Another 76 species were excluded as they lack a valid or known voucher to support their inclusion. With this update, the listed flora of Arkansas is treated more consistently with that of floras of other states in the region and with national lists.

The purpose of this current report, beyond communication of state and county noteworthy records, was to demonstrate the need for continued judgment and interpretation of floristic information, whether in the older hard-copy literature or in the newer data-based, on-line records. Records of each state need to be reviewed by experts in taxonomic groups as well as local experts to insure a correct name and proper documentation exists. Criteria for inclusion need to be carefully followed regarding invasive, escaped, waif, and naturalized plants. Equally important is to exclude species erroneously included in past lists. There may well be more exclusions than new additions (Ertter 2000). Documentation of known and valid vouchers as to herbarium of deposit, identity, collector, and number should be the basis for inclusion, not just a passage in the text, or a tone-map or dot-map. Literature errors may need to be removed more than once from the database. Increased efforts at quality control and assurance through time and effort will result in a continually improved and more powerful tool at both the state and national levels (Kartesz 2000).

ADDITIONS TO ARKANSAS FLORA

Agalinis nuttallii Shinners (Scrophulariaceae)—This is the "first report" for Arkansas of this historical plant, now considered extinct. First collected and named by Nuttall based on his work in Arkansas (Nuttall 1835, Palmer 1927) as *Gerardia longifolia* Nutt. Although similar to *G. holamantha* (Pennell) Pennell, Pennell (1935) asserted that it was distinct. The lack of conservation of the name *Gerardia* required a new combination that was made by Shinners (1962) in honor of its first collector. The species was listed for Arkansas by Lesquereux (1860). Surprisingly, the species was not listed, discussed, or excluded by Smith (1978, 1988), but was listed as an Arkansas endemic by Kartesz and Meacham (1999).

Voucher: **ARKANSAS:** along the bank of the Arkansas, locality not specified, *Nuttall s.n.* (BM, K, PH).

Azolla caroliniana Willd. (Azollaceae)—The first collection of this species from Arkansas was from a swamp at Spruell's Recreation Area, 2 mi north of Doddridge along US 71 on 19 May 1977 by B.L. Lipscomb. All other material of this genus from Arkansas was referable to *A. mexicana* Schlecht. & Cahm. ex K. Presl.

Voucher: **ARKANSAS: Miller Co.:** *Lipscomb 2064* (LRU).

Crataegus thermopegaea Palmer (Rosaceae)—This species is reported based on a collection by E.J. Palmer at Hot Springs, Arkansas in Apr and Oct 1925. It was described as a new species by Palmer (1926). Palmer described 67 species as new for *Cratageus*; this is the only one still recognized on national lists. The species was not recognized by Tucker (1976) or Smith (1978, 1988), but was recognized as an Arkansas endemic by Kartesz and Meacham (1999).

Vouchers: **ARKANSAS: Garland Co.:** *Palmer 26843* (A), *Palmer 26843* (G).

Cyrtomium falcatum (L.f.) K. Presl (Dryopteridaceae)—This is an escaped exotic species that can persist several years in Arkansas when its rhizome is well protected; plants remain wintergreen in southern to central Arkansas. The species is cultivated state-wide, escaping rarely, but persisting in urban waste areas, at least in Little Rock. A related species *Cyrtomium fortuneii* J. Sm. (Fortune's Net-vein Holly Fern) was collected in 1988 by Wilson Baker as part of a contract with The Nature Conservancy to study plants in the batture lands of Desha Co., Arkansas. Unfortunately, the voucher material was taken to Tall Timbers Research Station, Georgia, and remains unmounted and unreported. Therefore, the later collection from Little Rock was the first report of the genus from Arkansas.

Voucher: **ARKANSAS: Pulaski Co.:** *Peck 02744* (LRU).

Nerium oleander L. (Apocynaceae)—This is a very toxic horticultural shrub, escaping from landscapes to urban waste places in Boyle Park, Little Rock, evidently at least "root-hardy" and persisting in Arkansas.

Voucher: **ARKANSAS: Pulaski Co.:** *Peck 02-845* (LRU).

Polygala alba Nutt. (Polygalaceae)—This species was first collected in Arkansas on 21 May 1977 from a wooded hillside 12 mi north of Murfreesboro in Pike Co. by B.L. Lipscomb.

Voucher: **ARKANSAS: Pike Co.:** *Lipscomb 2177* (LRU).

Punica granatum L. (Punicaceae)—This horticultural shrub has persisted at old homesteads in Arkansas and has escaped to urban waste places and to Boyle Park, Little Rock, where it has persisted for decades.

Vouchers: **ARKANSAS: Little River Co.:** *Tucker 16121* (APCR), **Pulaski Co.:** *Luyet 8311* (LRU).

Ricinus communis L. (Euphorbiaceae)—A very toxic horticultural, suffrutescent plant or semi-perennial herb, escaping from cultivation and establishing small colonies in urban and rural waste or disturbed areas, now state-wide in Arkansas.

Vouchers: **ARKANSAS: Bradley Co.:** *Leslie 1515* (UAM). **Pulaski Co.:** *Luyet 137* (LRU). **Stone Co.:** *Leonard 124* (LRU), and by the author and deposited at LRU in 22 counties: **Arkansas Co.:** *02369*, **Baxter Co.:** *98117*, **Cleburne Co.:** *96185*, **Faulkner Co.:** *97321*, **Garland Co.:** *97268*, **Grant Co.:** *99244*, **Hot Spring Co.:** *97232*, **Independence Co.:** *96344*, **Izard Co.:** *96127*, **Jackson Co.:** *99176*, **Jefferson Co.:** *02376*, **Lonoke Co.:** *02276*, **Marion Co.:** *96432*, **Monroe Co.:** *96518*, **Phillips Co.:** *02333*, **Prairie Co.:** *02312*, **Saline Co.:** *02350*, **Searcy Co.:** *98253*, **Van Buren Co.:** *98278*, **White Co.:** *99561*, **Woodruff Co.:** *97566*, and **Yell Co.:** *02467*.

Schinus terebinthifolius Raddi (Anacardiaceae)—A toxic, invasive woody shrub-tree, was introduced into a backyard in Camden in southern Arkansas as a horticultural novelty. The tree with plentiful red berries was a Christmas tree "present" from Florida. It was planted and had survived 3 winters, with root suckers and seedlings produced around the original stock. The plants were eradicated by the homeowner upon advice of the author before it became further established or irreparably naturalized.

Voucher: **ARKANSAS: Ouachita Co.:** *Peck 90117* (LRU).

REINSTATEMENTS TO ARKANSAS FLORA

Acacia farnesiana (L.) Willd. (Mimosaceae)—This species was first reported for Arkansas by Demaree (1943). Tucker (1976) included this species, but considered it to be a "rare adventive." Smith (1978, 1988) excluded it from the state flora, as the specimen was sterile material [not unusual for woody plant collections], and he questioned the correctness of its identity. The voucher specimens are of this species, collected from a 3–4 m tall tree adjacent to the Arkansas River near Little Rock, but no longer present.

Voucher: **ARKANSAS: Pulaski Co.:** *Palmer 29600* (A, UARK).

Arabis glabra (L.) Bernh. (Brassicaceae)—This species was first reported for Arkansas by Branner and Coville (1891), compiled by Demaree (1943), and reported by Fernald (1950). Smith (1978) suggested that this record might be a misidentified *Arabis laevigata* (Muhl. ex Willd.) Poir., but he did not consult the voucher. Al-Shehbaz (1988) noted that M. Hopkins (1937) reported this species from Pulaski Co., AR. Smith (1988) excluded it again, but noted that "as it has not been recollected in the last 50 years [1895], I assume it is no longer extant in the state."

Voucher: **ARKANSAS: Pulaski Co.:** *Hasse s.n.* (NY).

Canavalia ensiformis (L.) DC. (Fabaceae)—Sauer (1964) reported this prehistoric American Indian domesticate for Arkansas based on a collection by Harvey in

1885 and by Jennings in 1938. All other specimens, particularly at UARK, are based on cultivated materials dating from 1930 to1959. The species was listed for Arkansas by Kartesz and Meacham (1999), citing Sauer (1964).

Vouchers: **ARKANSAS:** locality not specified, *Harvey s.n.* (GH), *Jennings s.n.* (F).

Cladium jamaicense Crantz (Cyperaceae)—The species was reported first by Branner and Coville(1891). Demaree (1943) reported this species based on that report and on his 1939 collection in Bradley Co., AR (*Demaree 19433* BRIT, MO). Without examining the vouchers, Smith (1978) listed it as "excluded" from Arkansas, based on its reported range in the floras of Texas and the Carolinas. Orzell and Bridges (1987) examined and verified the Demaree collections, but considered it to be probably extirpated from the state. Smith (1988) listed it as "excluded" in that it was only a waif and now extirpated from Arkansas. The species was recently collected in four Arkansas counties.

Vouchers: **ARKANSAS: Bradley Co.:** *Peck 98247* (LRU). **Calhoun Co.:** *Peck 20220* (LRU). **Ouachita Co.:** *Peck 20240* (LRU). **Union Co.:** *Peck 20234* (LRU).

Eragrostis trichodes (Nutt.) Wood (Poaceae)—The species was reported from Arkansas by Moore (1961) from two counties (Logan and Pulaski), listed by Gould (1975) from southwestern Arkansas, but excluded from the flora by Smith (1988), as one specimen (*Moore 470609* UAM) was a misidentified sheet of *E. hirsuta*. The 2nd specimen cited by Moore (1961) from Pulaski Co. is not at UARK. Kartesz and Meacham (1999) listed this species as present in Arkansas citing a Nuttall voucher at PH.

Voucher: **ARKANSAS:** without precise locality data, *Nuttall s.n.* (PH); **Pulaski Co.:** *Merrill 14* (UARK?).

Halesia diptera Ellis (Styracaceae)—The species was first reported for Arkansas by Branner and Coville (1891), compiled by Demaree (1943), and reported by Tucker (1976). Reveal and Seldin (1976) reviewed the taxonomy of this species and its varieties. Smith (1978) included this species in his first checklist, but he excluded it from the second edition (Smith, 1988), noting that it was collected only once in 1887 by Letterman, that "it has not been re-collected in the last century, [and] it is probably no longer extant in the state." R. G. Erickson (1989) discovered a second population in Lafayette Co., Arkansas. The specimen was sent to APCR, but was apparently lost before being mounted. More recently, a third population was located in Union Co. by R. Dale Thomas.

Vouchers: **ARKANSAS: Nevada Co.:** *Letterman s.n.* (ILL), **Union Co.:** *Thomas 109,060* (NLU).

Lygodesmia juncea (Pursh) D. Don (Asteraceae)—This species was first reported for Arkansas by Buchholz and Palmer (1926). The first vouchered collection was by Demaree (1943). Vuilleumier (1973) reported this species for Arkansas based on Demaree's 1937 collections. Tomb (1980) re-reported the species from Arkansas,

noting the locality as Magnet Cove, AR. Without examining vouchers or seeing the plant in the field, Smith (1978, 1988) excluded this species as being "only a waif," and therefore not part of the "normal Arkansas flora." Orzell and Bridges (1987) reported the status of this species in Arkansas as being "probably extirpated." Kartesz and Meacham (1999) reported this species as present in Arkansas, but cited Smith (1988).

Vouchers: **ARKANSAS: Hot Spring Co.:** *Demaree 16264* (BRIT, NY).

Prosopis glandulosa Torr. var. **glandulosa** (Mimosaceae)—Tucker (1976) reported this species based on collections by D. M. Moore in 1954 and 1955 in Pulaski Co., noting that it was a "rare adventive" of potentially long duration that was collected along the railroad tracks on the southern edge of Little Rock, apparently brought in with livestock. Smith (1978, 1988) excluded this species, considering it to be only a waif, and not "part of the normal flora."

Vouchers: **ARKANSAS: Pulaski Co.:** *Moore 54343, 55517* (UARK).

Rhynchospora colorata (L.) Pfeiffer (Cyperaceae)—First reported for Arkansas by Demaree (1943) based on his collections at Warren Prairie, Bradley Co., Arkansas. Smith (1978) listed this species for Bradley Co. and noted a potential report from Pope Co., Arkansas. Orzell and Bridges (1987) reported "a stand of thousands of plants from Little River County," but opined that the Bradley Co. population was extirpated. Smith (1988) reported this species for Bradley Co. and Little River Co., but noted that the Pope Co. record was erroneous, based on diseased material of a *Cyperus* sedge. Similarly diseased sedge plants occur in Bradley Co. Recently, the species was collected in another 10 counties.

Vouchers: **ARKANSAS: Ashley Co.:** *Sontag 76* (LRU). **Bradley Co.:** *Demaree 15044* (F, MO, BRIT, NY); *Demaree 19264* (GH, MO, NY, BRIT, UARK); *Demaree 19268* (BRIT); *Demaree 19269* (MICH, NLU, NY, TEX, UARK); *Logan 101* (UCAC). **Calhoun Co.:** *Marian 22* (LRU). **Columbia Co.:** *Smith 32* (LRU). **Drew Co.:** *Smith 32* (LRU). **Hempstead Co.:** *Sontag 108* (LRU). **Lafayette Co.:** *Smith 76* (LRU). **Little River Co.:** *Orzell 2726* (APCR, MO, NLU, BRIT, TEX, UARK). **Miller Co.:** *Sontag 63* (LRU). **Ouachita Co.:** *Bell 99* (LRU). **Union Co.:** *Peck 20235* (LRU).

Rosa canina L. (Rosaceae)—Smith (1978, 1988) excluded this species, based on a Franklin Co. collection, as it "probably represents a local escape or was persistent at an old home site; it should not be considered as a normal part of our flora." Yet, many species have entered the Arkansas flora by this method of introduction. Kartesz and Meacham (1999) listed it as "present," based on Smith (1988).

Voucher: **ARKANSAS: Franklin Co.:** *Davis 449* (UARK)

Sagina procumbens L. (Caryophyllaceae)—First reported by Branner and Coville (1891), and then listed by Demaree (1943). Without inspecting vouchers, Smith

(1978) excluded this species, suggesting that it was a misidentified *S. decumbens* (Ell.) Torr. and A. Gray. Crow (1978) noted that it was correctly named and was collected in Pulaski Co. in May 1886. Smith (1988) re-excluded this species, noting that it was "not re-collected in the intervening century."

Voucher: **ARKANSAS: Pulaski Co.:** *Hasse s.n.* (MONTU).

Trifolium stoloniferum Muhl. (Fabaceae)—Smith (1978) did not list this species, but noted it as a "possible addition" to the flora of Arkansas. Brooks (1983a, 1983b; Batgie, 1985) reported that it had been collected from Arkansas in 1896. Smith (1988) excluded it from the flora of Arkansas as it was "no longer extant—and I am therefore excluding it." This species has declined across its entire range since settlement.

Voucher: **ARKANSAS: Independence Co.:** *Eggert s.n.* (MO).

RE-EXCLUDED FROM ARKANSAS FLORA

Asclepias sullivantii Engelm. ex A. Gray (Asclepiadaceae)—First reported in Arkansas by Buchholz and Palmer (1926). This report was based on a collection from the southwestern corner of the University of Arkansas campus at Fayetteville, Washington Co. According to the card file by D. Moore kept at UARK, E.J. Palmer observed it on 12 Jun 1923, and it was collected by Buchholz on 13 Jun 1923 (*Buchholz 20145-6*). The voucher is not at UARK or MO, but it might be at the Arnold Arboretum. A second report was made erroneously by Smith (1978, 1988) from Jackson Co., Arkansas, based on a misidentified collection by D. Moore (*Moore 440164* UARK). Another specimen of this species was collected by E.J. Palmer from Jackson Co., Missouri, deposited at MO, and reported by Woodson (1954). Woodson (1954) did not map this species in Arkansas. The Palmer specimen label was typed on a "Flora of Arkansas" label, with the corrected state name of Missouri hand written above the crossed-out "Arkansas."

Asplenium ruta-muraria L. (Aspleniaceae)—Reported by Nuttall (1835) and uncritically re-reported a dozen times from Arkansas for more than 165 years, but a voucher specimen has never been located at BM, K, P, or in any Arkansas herbarium. This species was excluded many times from the flora of Arkansas (Smith 1978, Taylor 1984, Smith 1988, Peck and Taylor 1995). Kartesz and Meacham (1999) erroneously listed the species as present in Arkansas citing Smith (1988).

Burmannia biflora L. (Burmanniaceae)—Reported by Demaree (1943, p. 21) as his record, but without any comment. The species was not listed nor excluded by Smith (1978, 1988). A specimen from Cass Co., Texas, adjacent to Texarkana, Miller Co., Arkansas, exists at BRIT (per. comm., G. Diggs). The species occurs nearby in Louisiana as well.

Dryopteris ×neowherryi W.H. Wagner [*D. goldiana* × *marginalis*] (Dryopterida-

ceae)—Montgomery (1981) erroneously reported this hybrid from Arkansas in a summary of *Dryopteris* hybrid morphology, systematics, and phytogeography. Montgomery confused this hybrid with *D.* ×*leedsii* which does occur in Arkansas. Peck and Taylor (1995) and Peck (2000) specifically excluded this hybrid from Arkansas. Kartesz and Meacham (1999) erroneously listed this species as present in Arkansas citing Montgomery (1981).

Escobaria missouriense (Sweet) D.R. Hunt var. **similis** (Englem.) N.P. Taylor (Cactaceae)—Benson (1982) reported *Coryphantha missouriense* (Sweet) Britton and Rose var. *caespitosa* (Engelmann) Benson from Miller Co., AR, based on a specimen with only an indeterminent location of "Arkansas" [*Dyck s.n.*, 1857 (MO)]. Zimmerman (1985) referred to this taxa as *C. missouriensis* (Sweet) Britton and Rose var. *similis* (Englemann) A. Zimmerman and mapped it in Texas and Oklahoma, but not in Arkansas. Orzell and Bridges (1987) excluded this find by Benson (1982), considering it to be a Oklahoma record based on confusion over the concept of Arkansas Territory. The "Arkansas Territory" (1819 - 1836) also included what is modern Oklahoma. Smith(1988) agreed and cited Orzell and Bridges (1987). However, to accept this interpretation, one must assume that Arkansas had been a state for 21 years at the time the specimen was collected and that the collector did not know this. Kartesz and Meacham (1999) erroneously listed the species as present in Arkansas, but cited Smith (1988) who excluded it.

Huperzia ×**bartleyi** (Cusick) Kartesz & Gandhi [*H. lucidula* × *porophila*] (Lycopodiaceae)—Smith (1988) reported this as a "possible addition" to the flora of Arkansas, meaning that it might be found in the state in the indefinite future, but that it had not as of yet been so documented. Peck and Taylor (1995) specifically excluded this hybrid from the flora of Arkansas, noting that only *H. lucida* Michx. was known in Arkansas. Kartesz and Meacham (1999) erroneously listed this hybrid for Arkansas citing Smith (1988).

Krameria lanceolata Torr. (Krameriaceae)—This species was reported from Arkansas by Nuttall (1835), listed by Lesquereux (1860), and again by Branner and Coville (1891). Demaree (1943) compiled the name into his list, but a voucher has not been located. Smith (1978, 1988) excluded this species. Kartesz and Meacham (1999) erroneously listed the species as present in Arkansas, citing Demaree (1943). The origin of this record may be a Nuttall specimen from Oklahoma. Alternatively, there is a specimen collected in 1836 [*C.W. Short s.n.* MO] at the "Arkansas [River] at Leavenworth," a location within the Arkansas Territory, but now in present-day Oklahoma.

Lesquerella angustifolia (Torr. & A. Gray) Wats. (Brassicaceae)—This species was collected by Nuttall (1835) from "prairies near the Red River, Arkansas." Re-reported by Branner and Coville (1891), Small (1913), and listed by Demaree (1943). The collection location was actually in McCurtain Co., Oklahoma, then part of Arkansas Territory (Goodman, 1966). Rollins and Shaw (1973) excluded it. Smith

(1978) listed this species as a "possible addition" to the state flora. Smith (1988) excluded this species as it was never documented from present day Arkansas. The species was erroneously re-listed for Arkansas on some national e-lists.

Lesquerella gracilis (Hook.) Wats. var. **repanda** (Nutt.) Pays. (Brassicaceae)—This species was collected by Nuttall (1835) from "prairies near the Red River, Arkansas." Re-reported by Branner and Coville (1891), Small (1913), and listed by Demaree (1943). The location was actually in McCurtain Co., Oklahoma, then part of Arkansas Territory (Goodman, 1966). Rollins and Shaw (1973) and Smith (1978, 1988) excluded this species from the flora of Arkansas. This species was erroneously re-listed for Arkansas on some national e-lists.

Lonicera albiflora Torr. & A. Gray (Caprifoliaceae)—This species was reported from Arkansas by Small (1913). Ferguson (1966a) noted that the type locality was "Fort Towson, Arkansas." Fort Towson is in SE Oklahoma, another confusion regarding Arkansas Territory which included present day Oklahoma. This species was excluded by Smith (1978, 1988). Kartesz and Meacham (1999) erroneously re-listed the species as present in Arkansas, citing Smith (1988).

Rhynchosia minima (L.) DC. (Fabaceae)—This species was reported for Arkansas by Greer (1978) based on a specimen collected in the "Arkansas Refuge [White River?]," ostensibly in Phillips or Arkansas counties, but with a dot that was placed in Desha Co. The specimen (*Cory 45847* FSU) was actually from Aransas Co., Texas, Aransas National Wildlife Refuge. Smith (1988) excluded this species from Arkansas. Kartesz and Meacham (1999) erroneously re-listed this species as present in Arkansas, citing Smith (1988).

Rivina humilus L. (Phytolaccaceae)—This species was collected by Nuttall at "Red River, Arkansas" (voucher at NY), in present day Oklahoma, then Arkansas Territory. The species was reported by Branner and Coville (1891). Demaree (1943), who had never seen it in Arkansas, commented that this species must be "probably rare in the state." Smith (1978, 1988) did not list this species, and he only considered it as a "possible addition." Kartesz and Meacham (1999) erroneously re-listed the species as present in Arkansas, citing Smith (1988). Some confusion may have resulted from uncorrected specimen labels on duplicates, such as an E.J. Palmer specimen at MO (*E.J. Palmer #30521*), collected on 7 June 1926 from Brewster Co., Texas, typed on a "Flora of Arkansas" label blank with the correct state typed above the strike-over of "Arkansas."

Smilax auriculata Walt. (Smilacaceae)—This species was reported for Arkansas by Duncan (1967). Tucker (1976) noted it was an enigmatic, 500 mi range extension reported by Duncan (1967), but a voucher was not located. Smith (1978, 1988) mapped it in his Arkansas atlas without seeing a voucher, referring to Duncan (1967). Smith (1994) listed the species as a "possible addition" denoted by an asterisk. Kartesz and Meacham (1999) erroneously listed the species as present in Arkansas, citing Smith (1988). No Arkansas specimen vouchered this record; it was mismapped by Duncan (1967). Moore (1941) reported that *S.*

walteri was present in Arkansas near Hot Springs, Garland Co. It was also known from Hempstead Co. at this time (*Buchholz 395* UARK). Coker (1944) re-reported the presence of *S. walteri* in "swamps," in Garland Co., Arkansas. The dot for Garland Co. that belonged on the *S. walteri* map, was absent in Duncan (1967). A clerical error was made: the dot for *S. walteri* was incorrectly mapped onto the *S. auriculata* map and placed incorrectly in the adjacent Montgomery Co.

EXCLUSIONS FROM ARKANSAS FLORA

Agrostis capillaris L. (Poaceae)—The species was listed by Moore (1961); Smith (1988) noted the species as a "possible addition," citing that all earlier records were based on cultivated material (turf), not on escaped or established plants beyond cultivation; Kartesz and Meacham (1999) erroneously listed the species as "present," citing Smith (1988).

Arundinaria gigantea (Walt.) Muhl. subsp. **tecta** (Walt.) McClure (Poaceae)—Branner and Coville (1891) listed this variety for Arkansas without citing a voucher. Efforts since Buchholz and Palmer (1926) have failed to locate a known and valid voucher. Kartesz and Meacham (1999) listed this variety for Arkansas, citing the compiled list of Demaree (1943).

Asclepias rubra L. (Asclepidaceae)—This species was listed by Kartesz and Meacham (1999) for Arkansas, based on one of a series of unpublished manuscripts (A. Radford et al., eds. Vascular Flora of Southeastern United States). The species occurs to the south in Louisiana and eastward along the Gulf Coastal Plain (Woodson 1954), but a voucher from Arkansas has not been located.

Boltonia diffusa E.L. var. **diffusa** (Asteraceae)—Branner and Coville (1891) listed this variety for Arkansas without citing a voucher. Efforts since Buchholz and Palmer (1926) have failed to locate a known and valid voucher. Kartesz and Meacham (1999) listed this variety for Arkansas, citing the compiled list of Demaree (1943).

Buddleyja lindleyana Fortune ex Lindl. (Buddlejaceae)—Kartesz and Meacham (1999) listed this species as present in Arkansas and cited a reference to one of a series of unpublished manuscripts (A. Radford et al., eds. Vascular Flora of the Southeastern United States). Although known as a horticultural shrub planted across the state, it has not been reported to escape in Arkansas.

Carex debilis Mich. var. **rudgei** Bailey (Cyperaceae)—This variety was listed for Arkansas by Buchholz and Palmer (1926), compiled by Demaree (1943), tracked as *C. debilis* Michx. var. *pubens* Gray by Arkansas Natural Heritage Commission, reduced to synonymy by Smith (1988), and reinstated as present by Kartesz and Meacham (1999) citing ANHC. In Vol. 23 of Flora North America, the two varieties are considered to be a synonym of var. pubens, already known from Arkansas.

Carex microrhyncha Mack. (Cyperaceae)—Kartesz and Meacham (1999) listed this species for Arkansas based on a personal communication with S. D. Jones; Vol. 23 of Flora North America reduced it to a synonym of *C. umbellata* Schkuhr ex Willd., already known from Arkansas.

Carex tenera Dewey (Cyperaceae)—The species was listed by Smith (1968) as not present in Arkansas, but he considered it to be a "possible addition"; listed erroneously as "rare" for Arkansas by Kartesz and Meacham (1999) citing Smith (1988).

Carex verrucosa Muhl. (Cyperaceae)—This species was listed by Demaree (1943). It was reported by Smith (1968) as a "possible addition," as it lacked a known voucher. It was reinstated erroneously by Kartesz and Meacham (1999) as "present, but now extinct."

Chenopodium berlandieri Moq. var. **boscianum** (Moq.) H. A. Wahl (Chenopodiaceae)—Branner and Coville (1891) listed this variety for Arkansas without citing a voucher. Efforts since Buchholz and Palmer (1926) have failed to locate a known and

valid voucher. Kartesz and Meacham (1999) listed this variety for Arkansas, citing the compiled list of Demaree (1943).

Chloris cucullata Bisch. (Poaceae)—This species was listed by Branner and Coville (1891), compiled by Demaree (1943), excluded by Smith (1988), and erroneously re-listed as "?present" in Arkansas by Kartesz and Meacham (1999) citing Smith (1988).

Clinopodium vulgare L. (Lamiaceae)—This species was listed for Arkansas as *Satureja vulgaris* (L.) Fritsch. by Branner and Coville (1891), compiled by Demaree (1943), and erroneously re-listed by Kartesz and Meacham (1999). It is likely that this record was based upon mis-identified *Satureja arkansanum* (Nutt.) House. rather than upon a garden escape, but a voucher is lacking to confirm this.

Collinsonia canadensis L. (Lamiaceae)—This species was reported by Demaree (1943) and excluded by Smith (1968) as the record lacked known voucher. The species was erroneously re-instated by Kartesz and Meacham (1999), but they cited Smith (1988).

Corispermum americanum (Nutt.) Nutt. var. **americanum** (Chenopodiaceae)—This variety was not listed by Smith (1988). Kartesz and Meacham (1999) listed this variety for Arkansas and cited Smith (1988). Kartesz and Meacham (1999) did not list as present in Arkansas the related *C. americanum* (Nutt.) Nutt. var. *rydbergii* Mosyakin, which Smith (1988) documented in Arkansas under *C. hyssopifolium* L. Perhaps the compiler added the wrong variety and deleted the correct variety of this species for Arkansas.

Crataegus monogyna Jacq. (Rosaceae)—This exotic and horticultural species was listed without a voucher by Tucker (1976), based on the expert authority and memory of E.J. Palmer. Palmer visited UARK in 1955 to annotate specimens and left a hand-written list of *Crataegus* from Arkansas based in part on his memory. Smith (1978, 1988) listed it only as "possible" for Arkansas, citing Tucker (1976). Kartesz and Meacham (1999) erroneously re-listed it for Arkansas and cited Smith (1988). The list was not extant at UARK.

Crataegus succulenta Schrad. ex Link (Rosaceae)—This exotic and horticultural species was listed by Tucker (1976), based on the expert authority and memory of E.J. Palmer. Palmer visited UARK in 1955 to annotate specimens and left a hand-written list of *Crataegus* from Arkansas based in part on his memory. Smith (1978, 1988) listed it only as "possible" for Arkansas, citing Tucker (1976). Kartesz and Meacham (1999) erroneously listed it for Arkansas and cited Smith (1988). The list was not extant at UARK.

Crinum americanum L. (Liliaceae)—This species was listed by Branner and Coville (1891), compiled by Demaree (1943), excluded by Smith (1988), and reinstated as "present" by Kartesz and Meacham (1999) by citing Smith (1988). [The species was now excluded, as the record was not backed with a known voucher.]

Cucurbita maxima Duchesne (Cucurbitaceae) -This species was excluded by Smith (1988) referring to cultivated material from Newton Co. collected by Ralph Thompson in 1977; reinstated erroneously by Kartesz and Meacham (1999) based on Smith (1988). The species is not known in Arkansas beyond cultivation.

Cyperus thyrsiflorus Junghahn (Cyperaceae)—Kartesz and Meacham (1999) listed this species for Arkansas, based on a text passage in a monograph on Central and South American species (Tucker 1994). There are neither dots, maps, nor vouchers supporting this record. In Vol. 23 of Flora North America, on p. 185, the species was not mapped for Arkansas but occurs in the Gulf states to the south.

Desmodium canadense (L.) DC. (Fabaceae) — This species was reported by Demaree (1943), listed as not yet known from the state but "possible" by Smith (1978, 1988). The species does not in Arkansas according to Isely (1998), but is found to the north in Missouri and northeastern North America. Kartesz and Meacham (1999) considered it "?present" in Arkansas, citing "Gleason (1963)" [1952? or Gleason and Cronquist, 1963?] Without a known and valid voucher, the species remains excluded from the flora.

Drosera intermedia Hayne (Droseraceae)—This species was reported from Conway Co. by Moore (1951); Smith (1968) excluded this species as it was based on misidentification of *D. brevifolia* Pursh. The species was reinstated erroneously by Kartesz and Meacham (1999) by citing Smith (1968).

Eragrostis elliottii S. Wat. (Poaceae)—Kartesz and Meacham (1999) listed this species for Arkansas, citing the revised Flora of Missouri by Yatskievych (1999), who cited Texas manuals by Gould (1975) and Correll and Johnson (1970). A known voucher is lacking.

Erigeron philadelphicus L. var. **philadelphicus** (Asteraceae)—Branner and Coville (1891) listed this variety for Arkansas without citing a voucher. Efforts since Buchholz and Palmer (1926) have failed to locate a known and valid voucher. Kartesz and Meacham (1999) listed this variety for Arkansas, citing only the compiled list of Demaree (1943).

Erigeron pulchellus Michx. var. **pulchellus** (Asteraceae)—Branner and Coville (1891) listed this variety for Arkansas without citing a voucher. Efforts since Buchholz and Palmer (1926) have failed to locate a known and valid voucher. Kartesz and Meacham (1999) listed this variety for Arkansas, citing only the compiled list by Demaree (1943).

Eupatorium album L. var. **album** (Asteraceae)—Branner and Coville (1891) listed tnis variety for Arkansas without citing a voucher. Efforts since Buchholz and Palmer (1926) have failed to locate a known and valid voucher. Kartesz and Meacham (1999) listed this variety for Arkansas, citing only the compiled list by Demaree (1943).

Eustoma exaltatum (L.) Salib. ex G. Don subsp. **russellianum** (Hook.) Kartesz (Gentianaceae)—This variety was reported for Arkansas by Moore (1951). Shinners (1957) corrected the varietal name to *E. exaltatum* (L.) Salisb. subsp. *exaltatum*. The change was noted by Smith (1988) and the Arkansas Natural Heritage Commission. The incorrect variety was re-instated by Kartesz and Meacham (1999) as "present" and by citing the ANHC. Kartesz and Meacham (1999) also listed the correct varietal name for the species in Arkansas.

Glycyrrhiza lepidota Pursh (Fabaceae)—This species was reported by Branner and Coville (1891), compiled by Demaree (1943), and noted by Steyermark (1963). It was only listed as "possible" in Arkansas by Smith (1978,1988) as a voucher was not found. It was not mapped in Arkansas by Isely (1998). The species was erroneously listed by Kartesz and Meacham (1999) by citing only the compiled list by Demaree (1943).

Hieracium marianum Willd. (Asteraceae)—Kartesz and Meacham (1999) listed this species for Arkansas based on personal communication with Guy Nesom. Nesom does not recollect this communication, but thinks that this record is unlikely (pers. comm. Guy Nesom). Lacking a known voucher, the spe cies was excluded.

Humulus japonicus Sieb. & Zucc. (Cannabaceae)—This exotic and weedy species was listed as "present but extinct" in Arkansas by Kartesz and Meacham (1999), who cited Flora of North America (Vol. 3). Lacking a known voucher, the species was excluded.

Hydrophyllum macrophyllum Nutt. (Hydrophyllaceae)—All prior reports, such as in Smith (1988) are misidentified material of recently named *Hydrophyllum brownei* Kral & Bates. The species was erroneously re-instated for Arkansas by Kartesz and Meacham (1999) along with the correct species, *H. brownei*.

Lindera benzoin (L.) Blume var. **benzoin** (Lauraceae)—This variety was first reported by Branner and Coville (1891), compiled by Demaree (1943), but not mapped by Tucker (1976). Smith (1978, 1988) who assigned all Arkansas material to *L. benzoin* var. *pubescens* Willd., but the incorrect variety was reinstated by Kartesz and Meacham (1999) who cited Demaree (1943).

Linum lewisii Pursh var. **lewisii** (Linaceae)—The variety was listed by Branner and Coville (1891), compiled by Demaree (1943), excluded by Smith (1988) noting that Rogers (1963) mapped the species no closer than north-central Mississippi. Kartesz and Meacham (1999) reinstated this species as "?present" based on an "unattributed personal communication."

Lobelia puberula Michx. var. **puberula**

(Campanulaceae)—Branner and Coville (1891) listed this variety for Arkansas without citing a voucher. Efforts since Buchholz and Palmer (1926) have failed to locate a known and valid voucher. Kartesz and Meacham (1999) listed this variety for Arkansas, citing only the compiled list by Demaree (1943).

Lobelia siphilitica L. var. **ludoviciana** A. DC. (Campanulaceae)—This variety was reported by Demaree (1943) based on his own collections; listed for the state by Kartesz and Meacham (1999) citing Demaree (1943). All herbarium material in Arkansas and at BRIT with this name on Demaree collections was annotated as var. *siphilitica* by R. L. Wilbur, Duke University, in 1969.

Lonicera reticulata Raf. (Caprifoliaceae)—This species was reported by Demaree (1943) as *L. prolifera* (Kirchn.) Booth ex Rehd., but a voucher has not been located.; Kartesz and Meacham (1999) listed it as present in Arkansas citing Demaree (1943).

Lycopus ×sherardii Steele [*L. uniflorus* × *virginicus*] (Lamiaceae)—Henderson (1962) mapped this hybrid for Arkansas in the form of a shaded overlap of both parent species, but without dots evident or vouchers cited. Listed for Arkansas by Kartesz and Meacham (1999), based on Henderson (1962).

Lysimachia tonsa (Wood) Wood ex Pax & R. Kunth (Primulaceae)—This species was listed by Demaree (1943) as *Steironema tonsum* (Wood.) Bicknell, but was excluded by Smith (1988) as a voucher was lacking. The species was erroneously reinstated as present by Kartesz and Meacham (1999).

Magnolia pyramidata Bartr. ex Pursh (Magnoliaceae)—This species was reported for Arkansas by Hardin (1972), without voucher citations. Tucker (1976) and Smith (1977, 1988) excluded this species. Kartesz and Meacham (1999) erroneously re-listed this species for Arkansas based on Hardin (1972). No Arkansas vouchers are known. Specimens elsewhere may have small leaves that fit herbarium sheets rather than normal sized leaves of *M. tripetala* (L.) L., leading to misidentifications. Any plant from Arkansas would seem to be extralimital, based on the maps of both species in Little (1976).

Matelea carolinensis (Jacq.) Woods. (Asclepidaceae)—This species was listed by Branner and Coville (1891), compiled by Demaree (1943), and treated as an additional representative of *M. decipiens* (Alexander) Woods. by Smith (1988). The species was reinstated by Kartesz and Meacham (1999) citing only the compiled list by Demaree (1943).

Medeola virginiana L. (Liliaceae)—This species was listed by Branner and Coville (1891), compiled by Demaree (1943), and listed as a "possible addition" but not present by Smith (1988) as vouchers were not found. The species was erroneously reinstated as "present" by Kartesz and Meacham (1999) by citing Smith (1988).

Mirabilis linearis (Pursh) Heimerl (Nyctaginaceae)—This species was listed as *Oxybaphus angustifolia* (Pursh) B.L. Robbins by Branner and Coville (1891), compiled by Demaree (1943), and excluded by Smith (1988) as a voucher was lacking. The species was erroneously re-listed as "?present" by Kartesz and Meacham (1999) citing Smith (1988).

Nymphaea odorata Ait. subsp. **tuberosa** (Paine) Wiersma & Hellquist (Nymphaeaceae)—Kartesz and Meacham (1999) listed this variety for Arkansas, citing a text passage in the Muenscher (1944). Later treatments by Fassett (1957) and Crow and Hellquist (2000) place this variety to the north of Arkansas.

Oenothera nutans Atkinson & Bartlett (Onagraceae)—Kartesz and Meacham (1999) listed this species for Arkansas, citing Dietrich et al. (1997). The species was not mapped in Arkansas, nor do voucher citations list any Arkansas specimens in that reference.

Opuntia humifusa (Raf.) Raf. var. **austrina** (Small) Dress (Cactaceae)—Kartesz and Meacham (1999) listed this variety for Arkansas, citing only the compiled list by Demaree (1943). Great Plains Flora Association (1977) mapped this variety west of Arkansas, again a possible confusion based on Arkansas Territory that included Oklahoma.

Oxydendrum arboreum (L.) DC. (Ericaceae)—This species was first listed by Lesquereux (1860), re-listed by Branner and Coville (1891), listed again by Moore (1941), and compiled by Demaree (1943). It was excluded by Tucker (1976) as a voucher was lacking. It was re-excluded by Smith (1978, 1988). It was erroneously reinstated as "?present" by Kartesz and Meacham (1999). The species is known as a street tree in Arkansas, but it has not escaped.

Paronychia fastigiata (Raf.) Fern. var. **paleacea Fern.** (Caryophyllaceae)—Demaree (1943) reported this variety for Arkansas based on his own collections; Kartesz and Meacham (1999) listed this variety for Arkansas. All Demaree specimens with this name in Arkansas and at BRIT were annotated in 1985 by J. W. Thieret to be var. *fastigiata*, already known from Arkansas.

Pentodon pentandrus (K. Schum.) Vatke (Rubiaceae)—Smith (1988) noted its presence in adjacent counties in Louisiana based on MacRoberts (1988) and suggested that it might be searched for in Arkansas; Kartesz and Meacham (1999) erroneously listed it as "present" in Arkansas, citing Smith (1988).

Physocarpus opulifolius (L.) Maxim. var. **opulifolius** (Rosaceae)—First reported by Buchholz and Palmer (1926) and compiled by Demaree (1943). All Arkansas material was assigned to *P. opulifolius* (L.) Maxim. var. *intermedius* (Rydb.) Robinson by Tucker (1976). Smith (1978, 1988) agreed. Kartesz and Meacham (1999) erroneously reinstated the incorrect variety by citing Demaree (1943).

Physostegia digitalis Small (Lamiaceae)—Kartesz and Meacham (1999) listed this species as "?present" in Arkansas, referring to Cantino (1982). A review of this source shows no text passage mentioning this species in Arkansas, nor map dots in Arkansas, or vouchers.

Plantago major L. (Plantaginaceae)—This species was listed by Branner and Coville (1891), and compiled by Demaree (1943). It was listed as a "possible addition" but not present by Smith (1988) who noted the absence of a voucher. It was erroneously reinstated by Kartesz and Meacham (1999) citing only the compiled list by Demaree (1943).

Polygala verticillata L. var. **verticillata** (Polygalaceae)—Branner and Coville (1891) listed this variety for Arkansas without citing a voucher. Efforts since Buchholz and Palmer (1926) have failed to locate a known and valid voucher. Kartesz and Meacham (1999) listed this variety for Arkansas, citing only the compiled list by Demaree (1943).

Populus ×canadensis Moench. [*P. deltoides* × *nigra*] (Salicaceae)—This cultivated hybrid was listed for Arkansas by Kartesz and Meacham (1999). All specimens of this hybrid in Arkansas are cultivated materials from Washington Co. at UARK.

Populus ×canescens Small [*P. alba* × *tremula*] (Salicaceae)—This cultivated hybrid was listed for Arkansas by Kartesz and Meacham (1999). All specimens of this hybrid in Arkansas are cultivated materials from Newton Co. and Washington Co. at UARK.

Populus ×jackii Sarg. [*P. balsamifera* × *deltoides*] (Salicaceae)—This cultivated hybrid is planted in southern Arkansas, but although persisting and expanding as clones, it is not known from any wild population nor is it escaping from tree farms. The hybrid was listed by Tucker (1976) as present in persistent plantings. Smith (1978, 1988) excluded it from the flora as it had not spread or naturalized. Kartesz and Mecham (1999) erroneously listed it for Arkansas by citing Smith (1988).

Potamogeton epihydrus Raf. (Potamogetonaceae)—Kartesz and Meacham (1999) list this for Arkansas, citing a pers. communication with Robert Haynes. Haynes has no such recollection nor any records documenting a voucher for this record.

Potentilla millegrana Engelm. (Rosaceae)—Robertson (1974) remarked that this species "could" be in Arkansas; based on this passage, Kartesz and Meacham (1999) erroneously listed this species for Arkansas.

Pyracantha coccinea M. Roemer (Rosaceae)—Smith (1988) excluded this species as all known vouchers were based on cultivated

material, such as that at UARK collected by Ralph Thompson from Newton Co. The species was listed erroneously as "present" by Kartesz and Meacham (1999) by citing Smith (1988).

Quercus rubra L. var. **ambigua** (A. Gray) Fern. (Fagaceae)—The variety was listed by Kartesz and Meacham (1999) for Arkansas, based only on the compiled list by Demaree (1943). Tucker (1976) and Smith (1978, 1988) excluded this variety as they considered it to be a trivial name not reflective of geographic variation. Vol. 3 of Flora North America does not use this varietal name.

Quercus ×**humidicola** Palmer [*Q. bicolor* × *lyrata*] (Fagaceae)—This hybrid was listed by Demaree (1943). It was excluded by Tucker (1976) as one of the parents (*Q. bicolor*) is not known from Arkansas; Smith (1978, 1988) concurred. The hybrid was re-listed by Kartesz and Meacham (1999) by citing Demaree (1943). Perhaps some of the confusion can be traced to a specimen cited by Palmer (1948) from Pulaski Co., Illinois, [not Arkansas.]

Quercus ×**incomita** Palmer [*Q. falcata* × *marilandica*] (Fagaceae)—This hybrid was listed as present by Demaree (1943). Materials assignable to this hybrid for Arkansas were misidentified specimens of *Q.* ×*bushii* Sarg. [*Q. marilandica* × *velutina*], according to Palmer (1948, p. 19) and with his annotations made in 1955 at UARK. The hybrid was erroneously re-listed for Arkansas by Kartesz and Meacham (1999).

Ranunculus cymbalaria Pursh (Ranunculaceae)—Kartesz and Meacham (1999) listed this species for Arkansas, citing "Sida 1976." In that source, the species' distribution was summarized in a text passage (Keener, 1976) as including Texas, Oklahoma, Missouri, Illinois, and New Jersey, but not Arkansas; there are no dots or vouchers suggestive of an Arkansas occurrence.

Ranunculus pusillus Poir. var. **pusillus** (Ranunculaceae)—Branner and Coville (1891) listed this variety for Arkansas without citing a voucher. Efforts since Buchholz and Palmer (1926) have failed to locate a known and valid voucher. Kartesz and Meacham (1999) listed this variety for Arkansas, citing only the compiled list by Demaree (1943).

Rhynchospora nivea Boeckl. (Cyperaceae)—This species was first reported for Arkansas in Correll and Johnson (1970). It was probably based on misidentified Arkansas material of *R. colorata* (L.) Pfeiffer. All white-bracted *Rhynchospora* in Arkansas are specimens of *R. colorata*, a larger and coarser species typical of southeastern United States, rather than the Oklahoma–Texas species that is smaller and finer in form.

Rudbeckia bicolor Nutt. (Asteraceae)—Branner and Coville (1891) listed this species for Arkansas without citing a voucher. Efforts since Buchholz and Palmer (1926) have failed to locate a known and valid voucher. Kartesz and Meacham (1999) listed this variety for Arkansas, citing only the compiled list by Demaree (1943).

Salix amygdaloides Anderss. (Salicaceae)—This species was reported by Smith (1978, 1988) for Crittenden Co., Arkansas, but it was excluded by Argus (1986) as it was based on a misidentified specimen of *S. eriocephala*. Great Plains Flora Association (1977) mapped it in Franklin Co., Arkansas, but it was excluded by Argus (1986) as the specimen was collected in Franklin Co., Kansas.

Scutellaria incana Biehler var. **punctata** (Chapman) C. Mohr (Lamiaceae)—Kartesz and Meacham (1999) listed this variety for Arkansas, citing Fernald (1950). Epling (1942) does not map this variety in Arkansas, but does map *S. incana* Biehler var. *incana*. Lacking a known and valid voucher, this variety was excluded from the state flora.

Scutellaria nervosa Pursh (Lamiaceae)—Kartesz and Meacham (1999) listed this species for Arkansas, citing only the compiled list by Demaree (1943). Epling (1942) does not map this species in Arkansas. Lacking a known and valid voucher, this species was excluded from the state flora.

Sesuvium verrucosum Raf. (Aizoaceae)—This species was reported for Arkansas by Smith (1978, 1988), but without a voucher, referring to text passages in Correll and Johnson (1970). As a known and valid voucher has

not been found in the last 30 years, this species was excluded from the flora of Arkansas.

Smilax illinoensis Mangaly (Smilacaceae)—Kartesz and Meacham (1999) reported this species for Arkansas based on Mangaly (1968). Mangaly (1968) did not report *S. illinoensis* in Arkansas. A clerical error was made in reading Map 22 on p. 75, wherein a dot for *S. pulverulenta* was incorrectly assigned to *S. illinoensis*.

Sporobolus airoides (Torr.) Torr. (Poaceae)—This species was reported by Buchholz and Palmer (1926), compiled by Demaree (1943), reported with a voucher by Smith (1977). It was then reported as misidentified material of *Sporobolus cryptandrus* (Torr.) A. Gray by Smith (1988). It was tracked by Arkansas Natural Heritage Commission under the species historic name. It was reinstated erroneously by Kartesz and Meacham (1999) as "present" by citing only the compiled list by Demaree (1943) and ANHC.

Tridens muticus (Torr.) Nash var. **muticus** (Poaceae)—This variety was listed by Demaree (1943) as *Triodia mutica* (Torr.) Scribn., and compiled as present by Kartesz and Meacham (1999) citing Demaree (1943). The variety was excluded, as the record lacks a known and valid voucher.

Utricularia cornuta Michx. (Lentibulariaceae)—Kartesz and Meacham (1999) listed this species for Arkansas, citing Taylor (1989). Text passages state that this species was in Arkansas, but other passages state that its distribution is in the southern Gulf Coastal Plain (Florida to Texas), not Arkansas. As a known and valid voucher is lacking, the species was excluded.

Utricularia striata LeConte ex Torr. (Lentibulariaceae)—Kartesz and Meacham (1999) listed this species as present for Arkansas, citing text passages in Correll and Johnson (1970). Taylor (1989) did not list it for Arkansas. Lacking a known and valid voucher, the species was excluded.

Verbena ×deamii Moldenke (Verbenaceae)—This hybrid was listed by Kartesz and Meacham (1999) for Arkansas based only on the compiled list by Demaree (1943). The hybrid occurs to the north of Arkansas (Moldenke, 1980). A voucher has not been located in Arkansas or at BRIT.

Viola arvensis Murr. (Violaceae)—This species was listed for Arkansas by Branner and Coville (1891), compiled by Demaree (1943), but excluded from Arkansas in Russell (1965), and re-excluded in Smith (1978, 1988), who noted the absence of a voucher. It was reinstated erroneously by Kartesz and Meacham (1999) by citing only the compiled list by Demaree (1943).

Zanthoxylum hirsutum Buckl. (Rutaceae)—This species was reportedly in Arkansas according to Correll and Johnson (1970). It was relisted by Kartesz and Meacham (1999). All shrubby material in Arkansas is assignable to *Z. americanum* P. Mill.; larger plants are *Z. clava-herculis* L. (Tucker 1976).

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Spiridon E. Kintzios (ed.). 2003. **Oregano: The Genera *Origanum* and *Lippia*.** (ISBN 0-415-29991-8, hbk.). **Medicinal and Aromatic Plants–Industrial Profiles. Volume 25.** Series Editor: Roland Hardman. Taylor & Francis, 11 New Fetter Lane, London EC4P 4EE, UK and 29 West 35th Street, New York, NY 10001, U.S.A. (Orders: info@tandf.co.uk, www.tandf.co.uk, 44 (0) 207 583 9855, fax 44 (0) 207-842-2298, standing orders call 44 (0)1264 343071. **US and Canada Customers:** By mail: Taylor & Francis Customer Service, 10650 Toebben Drive, Independence, KY 41051, U.S.A., Toll Free Tel: 1-800-634-7064, Toll Free Fax: 1-800-248-4724, email: cserve@routledge-ny.com). $115.00, 277 pp., figs. (b/w photos, graphs, maps), tables, 7" × 10".

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Contents.—**PART 1:** Introduction; **1)** Profile of the multifaceted prince of the herbs. **PART 2:** Botany; **2)** Structural features of *Origanum* sp. **PART 3:** Taxonomy and chemistry; **3)** The taxonomy and chemistry of *Origanum*; **4)** The Turkish *Origanum* species; **5)** The chemistry of the genus *Lippia* (Verbenaceae). **PART 4:** Cultivation and breeding **6)** Cultivation of Oregano; **7)** Breeding of Oregano. **PART 5:** Pharmacology; **8)** The biological/pharmacological activity of the *Origanum* genus. **PART 6:** Uses of Oregano in the food industry; **9)** Processing, effects and use of Oregano and marjoram in foodstuffs and in food preparation. **PART 7:** Biotechnology; **10)** The biotechnology of Oregano (*Origanum* sp. and *Lippia* sp.). **PART 8:** Miscellaneous; **11)** Bibliometric analysis of agricultural and biomedical bibliographic databases with regard to medicinal plants genera *Origanum* and *Lippia* in the period 1981–1998; and Index.

NORTHWARD RANGE EXTENSION IN FLORIDA OF THE INVASIVE FERN *LYGODIUM MICROPHYLLUM* (LYGODIACEAE)

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ABSTRACT

A newly recognized population of the dangerous invasive fern *Lygodium microphyllum* has been found in Orange County in central Florida. This population of the weed is known to have persisted within a cypress swamp for almost 15 years, during which time the area experienced single or multi-night freezes of -2.5 to -5.5°C. This finding indicates that the weed could live in other USDA Cold Hardiness Zone 9 areas such as southern Texas, which the fern may be able to reach via its wind-borne spores.

RESUMEN

Se encontró en el Condado de Orange, en el centro de la Florida, una población reconocida recientemente del helecho invasivo y peligroso, *Lygodium microphyllum*. Se sabe que esta población de maleza ha persistido durante 15 años en una ciénaga de ciprés donde fue encontrado, durante tal periodo de tiempo el área experimentó heladas de -2.5 hasta -5.5°C durante una o más noches. Esta observación indica que la maleza podría vivir en otras áreas de la Zona de Resistencia al Frío (USDA) Numero 9, tal como el sur de Tejas, área que el helecho puede alcanzar por las esporas llevadas por el viento.

Lygodium microphyllum (Cav.) R.Br. (Lygodiaceae), known as Old World climbing fern, is considered to be the most serious weed of swamps and other moist habitats in southern Florida (Pemberton & Ferriter 1998). The weed is a severe problem because it dominates and displaces native vegetation, is spreading rapidly, and lacks adequate or affordable control measures. The fern is native to the Old World subtropics and tropics (Pemberton 1998), and was first found to be naturalized in Martin County in 1965 (Beckner 1968). Since then, the plant has spread to infest numerous susceptible habitats in all the Florida counties south of the northern shore of Lake Okeechobee. The weed covered an estimated 40,500 ha in Florida as of 1999 (A. Ferriter pers. comm.), and has expanded considerably since then. For instance, the infestation in Everglades National Park was estimated to occupy 810 ha in December 2002, but ca. 4,050 ha in August, 2003, despite aggressive aerial spraying with herbicides (T. Pernas and J. Taylor pers. comm.). The fern occurs much more sporadically north of Lake Okeechobee but is becoming more abundant. Prior to this report, the known northern limits of *L. microphyllum* were near Nalcrest in southeast Polk County and at a site in southern Brevard County (Pemberton & Ferriter 1998), both at

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ca. 27° 50' latitude. The Brevard County population is probably recent, first detected in 1997 (specimen sent to and confirmed by the author by M.A. Poole), but the Polk County population was present at least since 1979, when a herbarium sample (*Willson 353*, FLAS!) was collected.

During January 2003, an unrecognized population of *L. microphyllum* was examined in a cypress swamp east of Orlando. This site, at 28°30'42"N, represents a 70 km northern range extension of the plant.

Voucher specimens: **U.S.A. Florida. Orange Co.:** Eastern Service Area Wetland Treatment Facility on the W side of Alafa, Trail, 3 km S of Hwy. 408, ca. 8 km E of Orlando, along the boardwalk growing on bald cypress and other plants within the swamp, 27 Jan 2003, *Robert Pemberton s.n.* (USF).

Patches of the fern are present across an area of ca. 2 ha within the site, where the fronds twine up cypress tree trunks, *Taxodium distichum* (L.) Rich. forming large skirts consisting of living intertwined fronds layered over dead but persistent strands of rachis ("stems"). The large size of these skirts, like those in the long-established populations of the weed in southern Florida, indicates that this Orange County population is not new. *Lygodium microphyllum* was found during a vegetation analysis of this wetland during 1989, 1990, and 1991, but misidentified as *Lygodium japonicum* (Thunb.) Sw. (L. Swartz , Camp Dresser and McKee Inc., here forth CDM Inc., unpublished reports). *Lygodium japonicum* is the other invasive climbing fern that has naturalized in Florida, and the two species are often confused. *Lygodium japonicum* rarely occurs in deeper wetlands such as swamps, but it can't survive constant standing water like *L. microphyllum*. *Lygodium japonicum* has sterile pinnules ("leaflets") that are lobed or dissected, whereas *L. microphyllum* only occurs at wet sites in Florida and has sterile pinnules that are usually unlobed. Furthermore, *L. japonicum* is common in northern and central Florida (and occurs widely in the Southern states), but *L. microphyllum* occurs, with a few exceptions such as this one, in the southern third of Florida.

The occurrence of this newly recognized population of *L. microphyllum* in the northern part of Orange County, and its persistence for almost 15 years, demonstrates the plant's ability to tolerate significant single-night freezes. This population, which was first found by CDM Inc. staff during July1989, survived the 1989 Christmas freeze when temperatures dropped to -2.5–5.5°C during the three day period (Orlando International Airport Weather Station #6628 records). On all three dates (Dec. 23, 24, and 25), the daytime temperatures climbed above freezing. The airport is ca. 13 km to the southwest of the population. This more northerly occurrence indicates that the plant's ability to endure lower temperatures of short duration is greater than previously recognized. The observations suggest that *L. microphyllum* may be able to colonize additional areas in central Florida, and probably northward, especially along the relatively mild east coast of the state. The fact that *L. microphyllum* has not come to dominate the Orange County cypress swamp, despite being there for ca. 15 or more

years, suggests that the weed is not as aggressive in central Florida as it is in southern Florida. The ability of this fern to colonize and persist in central Florida, in USDA-Cold Hardiness Zone 9 (Cathey 1990), as well that wetlands in southern Texas and Louisiana are climatically suitable for the weed. The plant produces large numbers of spores and occurs on many oceanic islands within its native range both of which suggest that it may be able to reach these areas via its wind-borne spores (Pemberton & Ferriter 1998). Because this fern's gametophytes are self fertile (Lott et al. 2003), only one spore is needed to start a new infestation. Biological control may have the potential to control this weed (Pemberton, 1998); a suite of specialist insect and mite herbivores is currently being evaluated (Pemberton et al. 2002; Goolsby et al. 2003).

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From Taylor & Francis website.—"This book dispels the myths and incorrect information surrounding this [these] particular genera and will be of interest to graduate students, scientists, industry, and those using *Geranium* and *Pelargonium* as an alternative medicine."

Contents.—**1)** General introduction: **PART I;** *Geranium;* **2)** History of nomenclature, usage and cultivation of *Geranium* and *Pelargonium* species; **3)** The taxonomy of *Geranium* species and cultivars, their origins and growth in the wild; **4)** Phytochemistry of the genus *Geranium;* **5)** Cultivation and harvesting of *Geranium macrorrhizum* and *Geranium sanguineum* for medicinal use in Bulgaria; **6)** Essential oil of *Geranium macrorrhizum* L. production, extraction, distillation **and** use; **7)** Use of *Geranium* species extracts as herbal medicines. **PART 2;** *Pelargonium;* **8)** The taxonomy of *Pelargonium* species and cultivars, their origins and growth in the wild; **9)** Cultivation and sales of *Pelargonium* plants for ornamental use in **the** UK and worldwide; **10)** Growing pelargoniums in the garden, conservatory and for shows; **11)** Phytochemiistry of the genus *Pelargonium;* **12)** Pharmacology of Pelargonium essential oils and extracts *in vitro and in vivo.* **13)** Antimicrobial properties of *Pelargonium* extracts contrasted with that of *Geranium;* **14)** Essential oils from different *Pelargonium* species and cultivars: their chemical composition (using GC, GC/MS) and appearance of trichomes (under EM); **15)** Chemotaxonomy of *Pelargonium* based on alkaloids and essential oils, **16)** Phylogentical relationship within the genus *Pelargonium* based on the RAPD-PCR method of DNA analysis correlated with the essential oil composition; **17)** Geranium essential oil: standardisation, ISO; adulteration and its detection using GC, enantiomeric columns, toxicity and bioactivity; **18)** 'Rose-scented geranium' a *Pelargonium* grown for the perfume industry; **19)** Cultivation and distillation of Geranium oil from *Pelargonium* species in India; **20)** Micropropagation and biotechnological approaches to tissue culture of *Pelargonium* species and production of essential oils of scenteds; **21)** Geranium oil and its use in aromatherapy; **22)** Perfumery and cosmetic products utilising Geranium oil; **23)** New research: possible uses of various *Pelargonium* leaf oils and extracts as food preservatives; **24)** *Pelargonium reniforme* and *Pelargonium sidoides*: their botany, chemistry and medicinal use; **25)** Interactions between arthropod pests and pelargonium; **26)** Correlation of the chemical profiles of the essential oil of *Pelargonium* (Geranium oil) and others separately and in mixes, with their relaxant or stimulant properties in man and smooth muscle preparations *in vitro*; and Index.

MUHLENBERGIA DUBIA (POACEAE) IN CENTRAL TEXAS

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Muhlenbergia dubia Four. ex Hemsl. is a wide ranging species known from Texas and New Mexico, south through northeastern and north central Mexico to Michoacán, the state of México, Puebla, Oaxaca, and Veracruz (Correll & Johnston 1970; Gould 1975; Powell 1994; Herrera-Arrieta 2001). In Texas, it has been considered to be confined the Trans-Pecos region (Correll & Johnston 1970; Gould 1975; Powell 1994). It is a species primarily found on rocky hilltops and canyons in open oak-juniper/pine woodlands.

In 1912, M.E. Jones described a new species, *Muhlenbergia metcalfei*, from Grant County, New Mexico. Hitchcock (1951), Gould (1975), Powell (1994), and Jones et al. (1997) recognized *M. metcalfei* as distinct from *M. dubia* Four. ex Hemsl. and *M. rigida* (Kunth) Kunth. These two species are often difficult to distinguish from each other and both are reported as occurring in trans-Pecos Texas. However, Correll and Johnston (1970) and Martin and Hutchins (1980) recognized *M. metcalfei* as synonymous with *M. dubia*. Powell (1994) only tentatively recognized these taxa as distinct 'pending further studies.' He commented that it is 'difficult to defend specific status for such close entities with sympatric distribution.' Peterson et al. (2001) reduced *M. metcalfei* to synonymy with *M. rigida* (Kunth) Kunth in their synopsis of Poaceae, subfamily Chloridoideae, however, the reasons for this taxanomic placement are not presented.

There is no published record of *Muhlenbergia dubia* in central Texas. However, during field work for a flora of the Nature Conservancy of Texas' Love Creek Nature Preserve in Bandera County, Texas in the southern Edwards Plateau, *M. dubia* was collected by the author. Surveys conducted revealed numerous, large populations primarily in the uplands of the preserve, a habitat very similar to habitats in which the species occurs throughout its range. The original specimens were collected from a population on a sloping, open area with various grasses, scattered *Sophora secundiflora* (Ortega) Lag. ex DC, *Juniperus ashei* J. Buchholz, and *Diospyros texana* Scheele, and a few individuals of *Quercus fusiformis* Small and cacti. The substrate was a very thin, rocky, limestone soil. Subsequent collections were made from five other populations on the preserve, and one on a roadside that is very similar in habitat in Kerr County, Texas.

A review of the TEX, LL and TAES herbaria revealed that *Muhlenbergia*

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dubia actually was collected on the Edwards Plateau as early as 1967. A specimen of *M. dubia*, identified as *M. metcalfei*, from Edwards County, Texas, on the western edge of the Edwards Plateau, was collected in 1967 by Albert Jenkins. A specimen of *M. dubia* was collected by M.C. Johnston in Travis County, Texas in 1977. It was, however, originally misidentified as *M. rigens*, a similar species also from the trans-Pecos area of Texas. The existence of *M. dubia* on the Edwards Plateau of Texas is also known to the native plant nursery industry in central Texas (Dan Hosage, pers. comm.). Additional specimens should be expected from other counties throughout the Edwards Plateau. The species is relatively easy to distinguish from other central Texas species of *Muhlenbergia* by its contracted panicles, densely caespitose habit, and rounded, erect culms.

Specimens cited: **TEXAS. Bandera Co.:** Love Creek Nature Preserve. ca. 10 mi W of Medina, uplands of preserve, 1 Nov 2000, *Denny 16* (TEX); 26 Nov 2000, *Denny 60* (TEX); 26 Nov 2000, *Denny 61* (TEX); 15 Oct 2001, *Denny 359* (TEX); 15 Oct 2001, *Denny 361* (TEX); 17 Oct 2001, *Carr 20366* (TEX); stream terrace near hunter's cabin; 2 Sep 2001, *Denny 327* (TEX). **Edwards Co.:** (without specific locality) 14 Oct 1967, *Jenkins 49* (TAES). **Kerr Co.:** roadside of Highway 16, 9.3 mi N of Medina on E side of road, growing in rocks and thin rocky soil, 29° 54.761' N, 99° 15.204' W, 15 Oct 2001, *Denny 358* (TEX). **Travis Co.:** above the pour-off in Wildcat Hollow, the farthest up-river corner of Lake Austin, 26 Oct 1977, *M.C. Johnston 12442* (LL, TAES).

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ROTALA ROTUNDIFOLIA (LYTHRACEAE) NEW TO FLORIDA

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ABSTRACT

Naturalized populations of the Asian amphibious species *Rotala rotundifolia* are documented for three peninsular Florida counties. Distinguishing characters and a comment on invasive potential are also provided.

RESUMEN

Se documentan las poblaciones naturalizadas de la especie Asiática anfibia *Rotala rotundifolia* para tres condados de Florida peninsular. Se presentan también caracteres distintivos y un comentario acerca del potencial de invasión.

Rotala rotundifolia (Buch.-Ham. ex Roxb.) Koehne is a creeping amphibious perennial found mostly in mountainous areas across a broad native range extending from India to Japan and China (Cook 1979; TROPICOS 2003). It has been widely available in the international aquarium trade for more than three decades (e.g., Roe 1967; Stodola 1967) and more recently promoted in the water garden trade (e.g., Schuck 2000). "Dwarf Rotala," as it is often called in the trade, was first collected in Florida as an established escape in 1996 by the second author while consulting with water managers in the City of Coral Springs, Broward County in southeast Florida. A robust stand was spreading along the edge of a flood-control canal coursing through a residential area. Samples of naturalized populations have since been collected from a second canal location in Coral Springs, a flood-control canal in Palm Beach County to the north, and flood-control canals in the community of Lehigh Acres, Lee County in southwest Florida (Fig. 1).

Representative specimens: **FLORIDA. Broward Co.:** Coral Springs, one block N of Sample Road, in and along edge of canal about 46 m E of the intersection of Cardinal Road (NW 40th Street) and Woodside Drive, N26.2793 W80.2285, 8 Mar 1996, *Vandiver s.n.* (FLAS); Coral Springs, in and along

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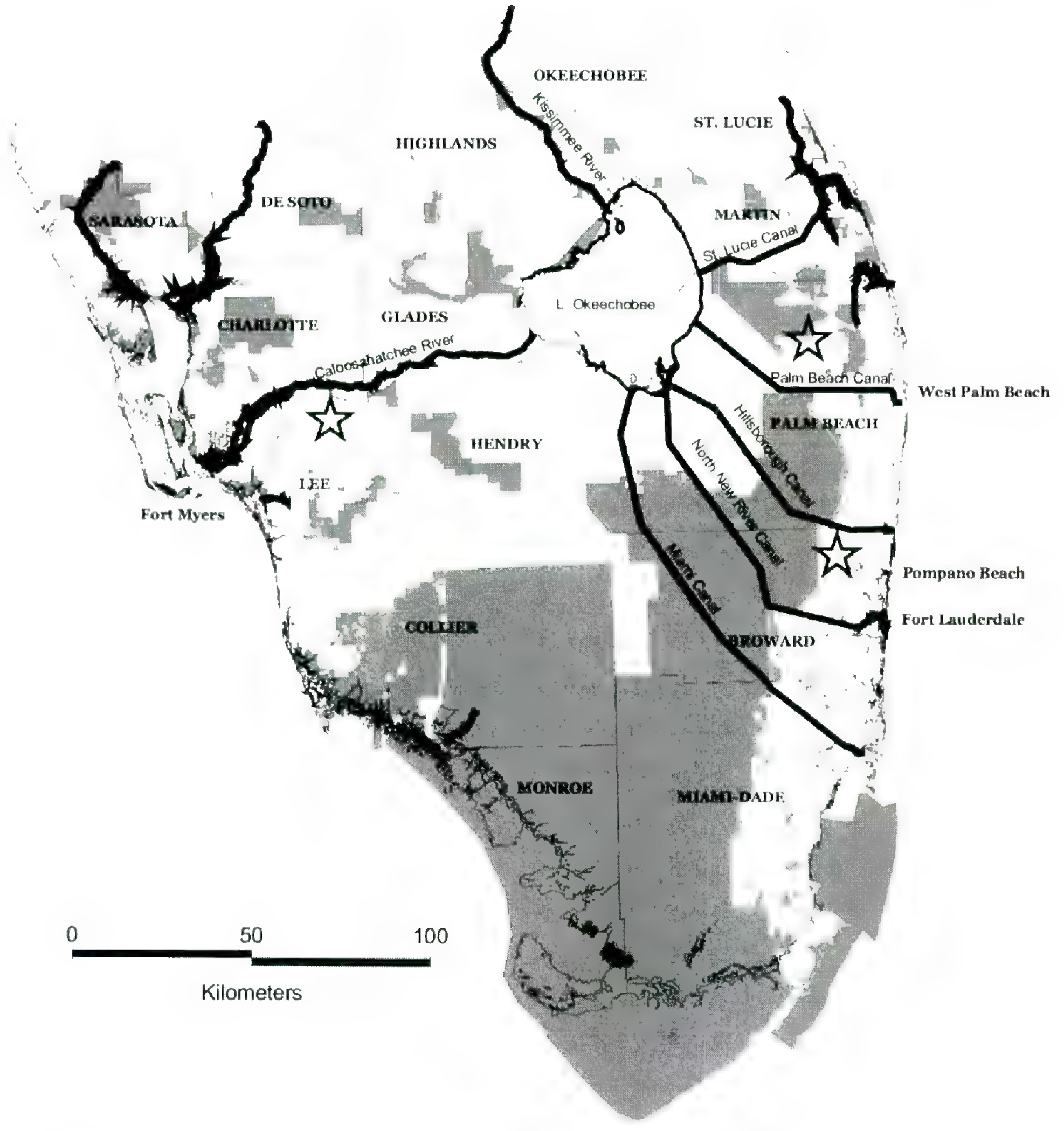


Fig. 1. Florida distribution of *Rotala rotundifolia* (stars). Each star marks two or more populations within a particular canal system (see text). Gray areas delineate public conservation lands (federal, state, local, and non-governmental).

W bank of canal on E side of Cypress Park, E side of Coral Springs Drive, 0.5 km S of Ramblewood Drive, N26.2476 W80.2662, 4 Apr 2000, *Vandiver s.n.* (FLAS, NY, SWSL, USF). **Lee Co.:** Lehigh Acres, S bank and shallows of Able Canal, N26.6118 W81.6412, 12 Apr 2002, *Jacono 418* (FLAS); 10 Jun 2002, *Burks 1215* (FLAS, FSU, FTG, USF). **Palm Beach Co.:** Indian Trail Improvement District, N of Loxahatchee and Lion Country Safari, Development Unit 5, two blocks S of North Lake Boulevard (CR-809A), in floating mats by culvert at the intersection of Hamlin Boulevard and District's "I" Canal (formerly 170th Avenue), N26.8089 W80.3114, 12 Jun 2001, *Vandiver s.n.* (FLAS, USF, Z).

Additional small patches or mats were noted in connecting canals of the Indian Trail system, Palm Beach County. A June 2002 survey of the Lehigh Acres canal system, Lee County, revealed additional patches at the junction of Charlie Diversion and Hickey Creek Canals (N26.6435 W81.6626) and on the east side of Harns Marsh, a filtration impoundment (N26.6520 W81.6872); none was

found at the outfall to the Orange River, a natural waterway that is part of the Caloosahatchee River basin. In North America, the species is known from just one other point of introduction—Tuscaloosa, Alabama, where it is well established around a campus pond (Haynes 2002, 2003 pers. comm.).

Only two congeners of this species are known to occur in the continental United States and Canada: the widespread native "toothcup," *Rotala ramosior* (L.) Koehne, and another introduced Asian species, *Rotala indica* (Willd.) Koehne, which is known from rice field edges in Butte County, California (Mason 1957; Oswald 1994) and in five parishes of Louisiana (Thieret 1972 [*Thieret 33544*, 1972, FLAS! FSU!]; R. D. Thomas [NLU] 2000 pers. comm.). All three species are low growing, glabrous herbs found in or near water; the leaves are decussate or rarely in whorls of three. *Rotala rotundifolia* (Fig. 2) is easily distinguished by a usually perennial habit; emersed leaves obovate to orbicular, to 2 cm long and 2.5 cm wide; a conspicuous rose-pink inflorescence of small spike-like racemes that elongate and become lax in post-anthesis; and 4-valved capsules (Cook 1979, 1990; Graham 1975; Reed 1977).

In the water-plant trade, *R. rotundifolia* has sometimes been confused with *R. indica* (e.g., Schuck 2000) and with an endemic of southwest India, *Rotala macrandra* Koehne (see discussion in Benl 1972). The annual *R. indica* has leaves with distinct cartilaginous margins, solitary flowers or short lateral spikes in upper leaf axils, calyx tubes longer than broad, and 2-valved capsules (Cook 1979). The Indian plant *R. macrandra* is much like *R. rotundifolia* in form and habit, but its submersed leaves are usually longer, to 2.5 cm, with their bases remaining more rounded (Rataj & Horeman 1977). Also, *R. macrandra*'s spike-like racemes usually remain dense in fruit, not elongated, and its stamens and styles are long exserted from the calyx tube (Cook 1979).

Presently, the naturalized populations of *Rotala rotundifolia* on Florida's east coast are much reduced in size—though not entirely eradicated—having responded well to routine tools of chemical control for aquatic plants that may impede water flow in these canal systems. Aquatic-label glyphosate and the aquatic-granular form of 2,4-dichlorophenoxyacetic acid have proven to be the most successful herbicides in stopping the spread of plants (2003 pers. comm., T. Narrow, N. Sculy). Multiple tools are used in the canals, including sterile triploid grass carp, or white amur (*Ctenopharyngodon idella* (Valenciennes)), as a biocontrol agent. However, these herbivorous fish apparently are not inclined to eat this species; they have been observed nibbling at submersed foliage of *R. rotundifolia* and immediately spitting it out (2003 pers. comm., T. Narrow).

On the west coast in the Lehigh Acres system, the current situation is less encouraging, with significant spread of shoreline patches and floating mats in the canals (2003 pers. comm., K. Waugh). However, managers are trying different tools and continuing to check for plants at the outfall water gates.

Florida's widely separated populations no doubt represent multiple intro-



FIG. 2. *Rotala rotundifolia*, in cultivation at quarantine research garden, Tallahassee, Florida. **a.** Orbicular leaves and spike-like racemes. **b.** Submersed leaves, light green, decussate. Growing in a concrete vat with native marsh plants, this species has competed well and overwintered here for at least 15 years, with occasional spread to damp graveled ground between vats (by fallen stem fragments). Cultivation vouchered by *Hall 1842*, 1988 (FLAS) and *Anderson 15431*, 1995 (FSU).

ductions, most likely by dumping of unwanted aquarium or water-garden material. Within each canal system, the plants have probably spread by floating stem fragments, which root adventitiously at lower nodes. Seeds have been observed in collected plant samples, but their levels of viability and germination under Florida conditions are not known. Cook (1979) considered this species self-incompatible and insect-pollinated based on his cultivation studies.

The proximity of natural waterways and wetland conservation lands to the canal systems (Fig. 1) calls for close monitoring to prevent inadvertent transport of viable stem fragments, and possibly seeds, to natural habitats. More educational effort is also needed to revise the age-old human habit of inappropriate disposal of unwanted goods.

ACKNOWLEDGMENTS

Our thanks go to local resource managers who assisted in the field and shared their experience, Christine Kooienga, Terry Narrow, Nick Sculy, and Ken Waugh; to Rob Kipker for generating the GIS-based map; and to C.D.K. Cook for confirming identification of a duplicate specimen.

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Each volume in the series discusses the history and botany of each genus, and provides an in-depth look at areas such as commercial cultivation, chemical and/or pharmacological aspects, toxicology, current and/or future products, etc.

SATYAJIT D. SARKER and YUJI MARUYAMA (eds.). 2002. **Magnolia: The Genus *Magnolia*.** (ISBN 0-415-28494-5, hbk.). **Medicinal and Aromatic Plants–Industrial Profiles. Volume 28.** Series Editor: Roland Hardman. Taylor & Francis, 11 New Fetter Lane, London EC4P 4EE, UK and 29 West 35th Street, New York, NY 10001, U.S.A. (Orders: info@tandf.co.uk, www.tandf.co.uk, 44 (0) 207 583 9855, fax 44 (0) 207-842-2298, standing orders call 44 (0)1264 343071. **US and Canada Customers:** By mail: Taylor & Francis Customer Service, 10650 Toebben Drive, Independence, KY 41051, U.S.A., Toll Free Tel: 1-800-634-7064, Toll Free Fax: 1-800-248-4724, email: cserve@routledge-ny.com). $120.00, 187 pp., numerous b/w photos drawings and tables, 7" × 10".

From Taylor & Francis website.—"The genus *Magnolia* consists of several medicinally important species most of which come from Far East Asia. Many species of this genus have traditionally been used in China and Japan to treat various illnesses, from simple headaches to complicated cancer, and because of their versatility have more recently been incorporated into commercially successful medicine preparations. And with the revival of interest in herbal and oriental traditional medicines, many of these *Magnolia*-containing preparations have captured a significant proportion of the drug market in the Western countries. In recent years several studies have been performed with *Magnolia* species, resulting in the isolation of a number of bioactive compounds and discovery of new biological and pharmacological activities."

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BOOK RECEIVED

RONALD L. STUCKEY (compiler). 2003. **Linking Ohio Geology and Botany. Papers by Jane L. Forsyth.** (ISBN 0-9668034-7-7, hbk.). Ronald L. Stuckey, RLS Creations, Columbus, OH, U.S.A. (Orders: Ronald L. Stuckey, RLS Creations, P.O. Box 12455, Columbus, OH 43212-0455, U.S.A., 919-962-0522). $30.00, 338 pp., b/w photos, color photos, maps, drawings, graphs, tables, 8 1/2" × 11".

IN MEMORIAM

CHESTER MORRISON ROWELL, JR.

1925–2003

Jim Blassingame

2020 Mustang

Levelland, TX 79336-6704, U.S.A.

The botanical community of Texas expresses its sorrow upon the death of Chester M. Rowell of Marfa, Texas, June 5, 2003.

Chester was born December 2, 1925 in Burnet County, Texas the eldest son of Chester Morrison Rowell and Irene Gahagan Rowell. He received his B.S. from the University of Texas in 1947, his M.S. from Texas A&M University in 1949 and his Ph.D. from Oklahoma State University in 1967.

Chester taught at Texas A & M University from 1949 to 1957, Texas Tech University from 1957 to 1970 and Angelo State University from 1970 to 1987. He was the curator of the herbaria at Texas Tech University and Angelo State University. He served as chairman of the Department of Biology at Angelo State University from 1973 to 1982. After his retirement he was an adjunct Professor of Biology at Sul Ross State University.

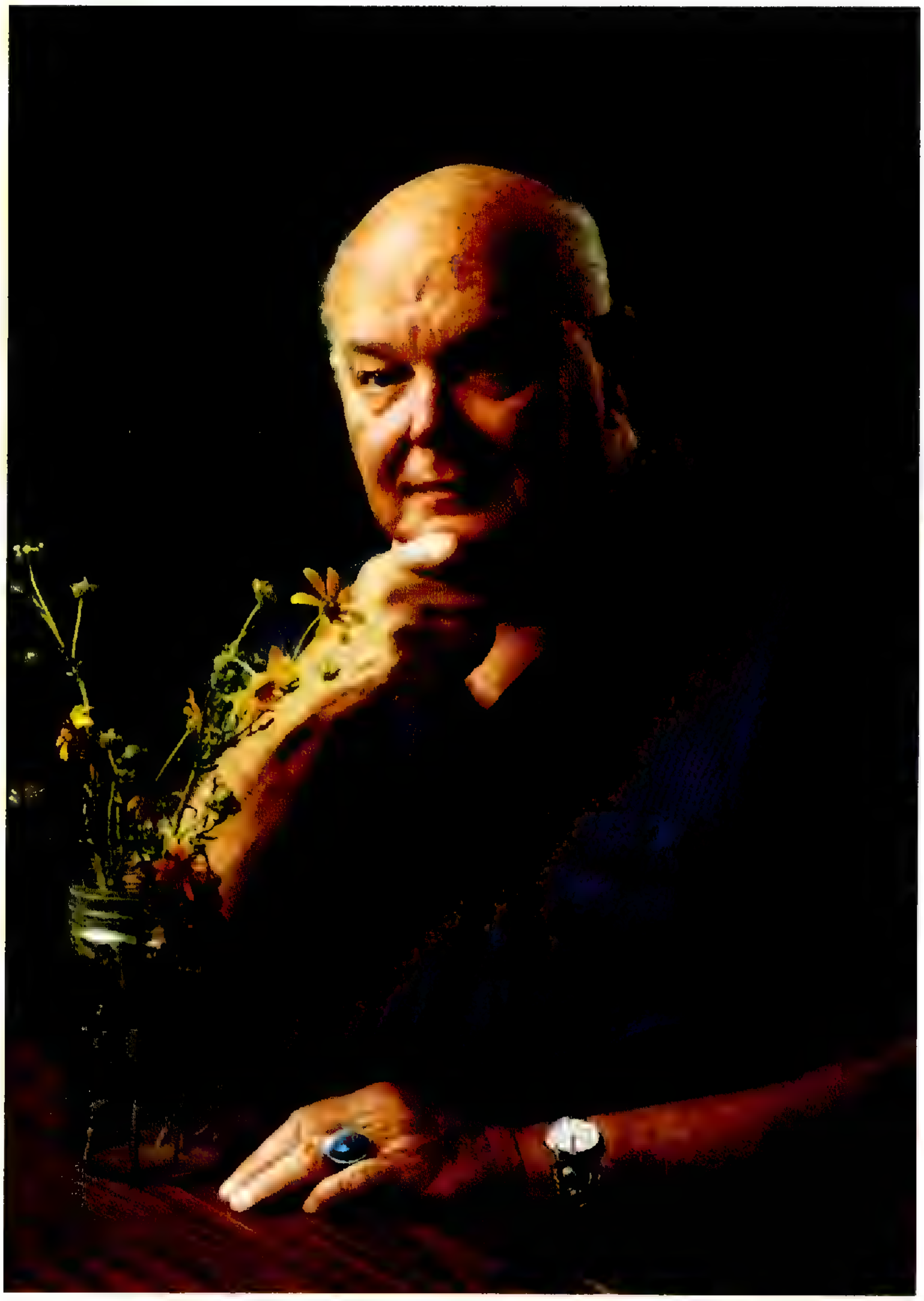
Professor Rowell did research on the flora of Southwestern U.S. and Mexico, authored several scientific papers, presented papers at scientific meetings and was author and co-author of two books. Chester was the scientific editor of the Native Plant Society of Texas. Dr. Rowell was a driving force in building the herbaria at Texas Tech University and Angelo State University in to excellent regional collections. He worked on toxic plants and endangered species in Texas. He was an advisor to the Texas Department of Parks and Wildlife for floristic and habitat studies.

Chester was the former President of the Southwestern Association of Naturalists. Dr. Rowell was the recipient of many awards and honors. He was active in professional societies and other organizations.

Dr. Rowell was a respected researcher, valued teacher, dedicated mentor and generous friend to people all around the country. He had a lifelong love affair with photography. His enthusiasm for teaching, learning and scholarship, his quick wit and cooperative spirit, were a role model for all who knew him.

Chester Rowell was a teacher and a friend to all of those interested in the botany of any area. Early in his career he decided that his students should be exposed to life in the field and not just in the laboratory. After this decision

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Chester M. Rowell (1925–2003)

Chester's life became one continuous field trip or collecting trip. All of his students and friends were given the opportunity many times to partake in such an experience. Chester was very proud to be a professional plant taxonomist. However, he was most proud to be a teacher as a source of stimulation and exciting guide for the intellectual development of young people and friends. He insisted that events of each life should be recorded on film. If you didn't have a camera, he would help you remedy the oversight with encouragement or a gift, usually the latter. Chester enriched the lives of most botanists, photographers, students and friends that he came in contact with.

Chester died June 5, 2003 in Midland, Texas at the age of 77. His many friends and associates will miss him greatly.

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Each volume in the series discusses the history and botany of each genus, and provides an in-depth look at areas such as commercial cultivation, chemical and/or pharmacological aspects, toxicology, current and/or future products, etc.

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P.N. RAVINDRAN and K.J. MADHUSOODANAN (eds.). 2003. **Cardamon: The Genus *Elettaria*.** (ISBN 0-415-28493-7, hbk.). **Medicinal and Aromatic Plants–Industrial Profiles. Volume 30.** Series Editor: Roland Hardman. Taylor & Francis, 11 New Fetter Lane, London EC4P 4EE, UK and 29 West 35th Street, New York, NY 10001,

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STEPHEN FREER. 2003. **Linnaeus' Philosophia Botanica.** (ISBN 0-19-850122-6, hbk.). Translated from the Latin in 1751 by Stephen Freer. Oxford University Press. (Orders: Oxford University Press, 2001 Evans Road, Cary, NC 27513, U.S.A., 800-451-7556, 919-677-1303 fax, www.oup.com). $277.50, 402 pp., 10 plates with numerous figs., 8 1/2" × 11".

What a fascinating book this is, the translation of Carol Linnaeus' *Philosophia Botanica* (The Science of Botany). The work was originally published in Latin in 1751 in Stockholm and Amsterdam. Stephen Freer's translation is a blessing to botanists, taxonomists, historians, and other interested parties; it gives a new lease on and insight into the work of the father of modern systematics, Carl Linnaeus.—*Barney Lipscomb, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., barney@brit.org*

EDZARD ERNST (ed.). 2003. **Hypericum: The Genus *Hypericum*.** (ISBN 0-415-36954-1, hbk.). **Medicinal and Aromatic Plants–Industrial Profiles. Volume 31.** Series Editor: Roland Hardman. Taylor & Francis, 11 New Fetter Lane, London EC4P 4EE, UK and 29 West 35th Street, New York, NY 10001, U.S.A. (Orders: info@tandf.co.uk, www.tandf.co.uk, 44 (0) 207 583 9855, fax 44 (0) 207-842-2298, standing orders call 44 (0)1264 343071. **US and Canada Customers:** By mail: Taylor & Francis Customer Service, 10650 Toebben Drive, Independence, KY 41051, U.S.A., Toll Free Tel: 1-800-634-7064, Toll Free Fax: 1-800-248-4724, email: cserve@routledge-ny.com). $120.00, 241 pp., figs. (color and b/w photos, line drawings, graphs), tables, 7" × 10".

From Taylor & Francis website.—"St John's wort (*Hypericum perforatum*) is one of the best-selling herbal medicines worldwide. This landmark book provides a summary of our current knowledge on

a wide range of issues. It covers botany and includes plant infections, cultivation, manufacturing, standardisation, quality control, biochemistry, pharmacology and clinical application. Within this wide range of topics this volume aims to tackle some previously unanswered questions, such as: Which are the pharmacologically active compounds? Is St John's wort effective for severe depression? What are its mechanisms of action? What are the long-term effects and risks? Should St John's wort products be marketed as dietary supplements or as drugs? How does it compare to synthetic drugs for the same indication?"

Contents.—**1)** *Hypericum* botany; **2)** *Colletotrichum gloeosporioides* as the cause of St John's wort (*Hypericum perforatum*) dieback in Switzerland and breeding for a tolerant variety; **3)** A virus causing vein yellowing and necrotic leaf spots of St John's wort (*Hypericum perforatum* L.); **4)** St John's wort herb extracts: manufacturing, standardisation and characterisation; **5)** Culture and biotechnology of *Hypericum*; **6)** Chemical constituents of *Hypericum* ssp.; **7)** Determination of hypericins and hyperforin in herbal medicinal products; **8)** Secondary metabolites content of *Hypericum* sp. in different stages and plant parts; **9)** Herbal medicinal products of St John's wort: manufacturing and quality control; **10)** The potential of *in vitro* cultures of *Hypericum perforatum* and of *Hypericum androsaemum* to produce interesting pharmaceutical compounds; **11)** The clinical pharmacology of *Hypericum perforatum*; **12)** Hypericin as a potential antitumour agent (the work of Professor Kyurig-Tae Lee's group in Seoul); **13)** Neuropsychopharmacological studies on Indian *Hypericum perforatum* Linn; **14)** *Hypericum* in the treatment of depression; and Index.

AMIT KRISHNA DE (ed.). 2003. **Capsicum: The Genus *Capsicum*.** (ISBN 0-415-29991-8, hbk.). **Medicinal and Aromatic Plants–Industrial Profiles. Volume 33.** Series Editor: Roland Hardman. Taylor & Francis, 11 New Fetter Lane, London EC4P 4EE, UK and 29 West 35th Street, New York, NY 10001, U.S.A. (Orders: info@tandf.co.uk, www.tandf.co.uk, 44 (0) 207 583 9855, fax 44 (0) 207-842-2298, standing orders call 44 (0)1264 343071. **US and Canada Customers:** By mail: Taylor & Francis Customer Service, 10650 Toebben Drive, Independence, KY 41051, U.S.A., Toll Free Tel: 1-800-634-7064, Toll Free Fax: 1-800-248-4724, email: cserve@routledge-ny.com). $125.00, 275 pp., figs. (b/w photos, graphs), tables, 7" × 10".

From Taylor & Francis website.—"This book, written by experts, includes material that deals with a variety of aspects, including ethnobotany, chemistry, pharmacology, toxicology, cultivation, analysis, tissue culture and commercial aspects of Capsicum.

Contents.—**1)** *Capsicum*: historical and botanical perspectives; **2)** A glimpse of the world trade in *Capsicum*; **3)** Chemistry and quality control of *Capsicums* and *Capsicum products*; **4)** Pungency principles in *Capsicum* - analytical determinations and toxicology; **5)** Biosynthesis of capsaicinoids in **Capsicum; 6)** Biotechnological studies on *Capsicum* for metabolite production and plant improvement; **7)** Irrigational aspects of *Capsicum*; **8)** The cultivation and processing of *Capsicum* in India; **9)** The preservation and production of *Capsicum* in Hungary; **10)** Post-harvest handling and processing of *Capsicums*; **11)** Advances in post-harvest processing technologies of *Capsicum*; **12)** The storage of *Capsicum*; **13)** Current requirements on paprika powder for food industry; **14)** Adulterants, contaminants and pollutants in *Capsicum* products; **15)** Colour differences in peppers and paprikas; **16)** Future perspectives of capsaicin research; and Index.

ALISTER D. MUIR and NEIL D. WESTCOTT (eds.). 2003. **Flax: The Genus *Linum*.** (ISBN 0-415-30807-0, hbk.). **Medicinal and Aromatic Plants–Industrial Profiles. Volume 34.** Series Editor: Roland Hardman. Taylor & Francis, 11 New Fetter Lane, London EC4P 4EE, UK and 29 West 35th Street, New York, NY 10001, U.S.A. (Orders: info@tandf.co.uk, www.tandf.co.uk, 44 (0) 207 583 9855, fax 44 (0) 207-842-2298, standing orders call 44 (0)1264 343071. **US and Canada Customers:** By mail: Taylor & Francis Customer Service, 10650 Toebben Drive, Independence, KY 41051, U.S.A., Toll Free Tel: 1-800-634-7064, Toll Free Fax: 1-800-248-4724, email: cserve@routledge-ny.com). $135.00, 307 pp., figs. (b/w photos, line drawings, graphs), tables, 7" × 10".

From Taylor & Francis website.—"This volume is a comprehensive review of the genus covering all aspects of the taxonomy, chemistry, cultivation, pharmacology and commercial uses of flax, and includes chapters on the disease prevention potential of these plants

Contents. **1)** Introduction: history of the cultivation and uses of flaxseed, **2)** Cultivated flax and the genus *Linum* L.: Taxonomy and germplasm conservation; **3)** Chemical studies on the constituents of *Linum* spp.; **4)** Cultivation of flax; **5)** Principal diseases of flax; **6)** Principal insect pests of flax; **7)** The contribution of a-linolenic acid in flaxseed to human health; **8)** The role of flaxseed lignans in hormone-dependent and independent cancer; **9)** Flaxseed in the prevention of cardiovascular diseases; **10)** Flaxseed and flaxseed lignans: Effects on the progression and severity of renal failure; **11)** Mammalian metabolism of flax lignans; **12)** Flaxseed constituents and human health; **13)** Traditional food and medicinal uses of flaxseed; **14)** Use of flaxseed in animal diets to create consumer products with modified fatty acid profiles; **15)** Current market trends and economic importance of oilseed flax; **16)** Current regulatory status of flaxseed and commercial products; and Index.

GULSEL M. KAVALALI (eds.). 2003. ***Urtica*: Therapeutic and Nutritional Aspects of Stinging Nettles.** (ISBN 0-415-30833-X, hbk.). **Medicinal and Aromatic Plants–Industrial Profiles. Volume 37.** Series Editor: Roland Hardman. Taylor & Francis, 11 New Fetter Lane, London EC4P 4EE, UK and 29 West 35th Street, New York, NY 10001, U.S.A. (Orders: info@tandf.co.uk, www.tandf.co.uk, 44 (0) 207 583 9855, fax 44 (0) 207-842-2298, standing orders call 44 (0)1264 343071. **US and Canada Customers:** By mail: Taylor & Francis Customer Service, 10650 Toebben Drive, Independence, KY 41051, U.S.A., Toll Free Tel: 1-800-634-7064, Toll Free Fax: 1-800-248-4724, email: cserve@routledge-ny.com). $90.00, 83 pp., 1 b/w photo, tables, 7" × 10".

From Taylor & Francis website.—"This volume explores the historical and modern uses of the *Urtica* genus. An account of the botanical aspects of the genus is followed by a comprehensive review of the recent research into its biologically active constituents. With further coverage of the therapeutic uses and its nutritional value, this book presents an absorbing and all-encompassing account of the medicinal potential of *Urtica*, which will be of considerable interest to herbalists, health scientists and botanists as well as researchers in the pharmaceutical industry.

Contents.—**1)** An introduction to *Urtica* (botanical aspects); **2)** Historical and modern uses of *Urtica*; **3)** The chemical and pharmacological aspects of *Urtica*; **4)** Various therapeutic uses of *Urtica*; **5)** The therapeutic uses of *Urtica* in benign prostatic hyperplasia; **6)** Nutritional evaluation of *Urtica* species; **7)** *Urtica* products; and Index.

Traditional Herbal Medicines for Modern Times

YUKIO OGIHARA and MASAKI ABURADA (eds.). 2003. **Sho-Saiko-To: Scientific Evaluation and Clinical Applications.** (ISBN 0-415-30837-2, hbk.). **Traditional Herbal Medicines for Modern Times. Volume 4.** Series Editor: Roland Hardman. Taylor & Francis, 11 New Fetter Lane, London EC4P 4EE, UK and 29 West 35th Street, New York, NY 10001, U.S.A. (Orders: info@tandf.co.uk, www.tandf.co.uk, 44 (0) 207 583 9855, fax 44 (0) 207-842-2298, standing orders call 44 (0)1264 343071. **US and Canada Customers:** By mail: Taylor & Francis Customer Service, 10650 Toebben Drive, Independence, KY 41051, U.S.A., Toll Free Tel: 1-800-634-7064, Toll Free Fax: 1-800-248-4724, email: cserve@routledge-ny.com). $120.00, 223 pp., 81 figs. (b/w photos, graphs), tables, 7" × 10".

From Taylor & Francis website.—"Sho-Saiko-To serves as a reference for researchers and practitioners who wish to gain a scientific understanding of Sho-Saiko-To and discover how this and other Kampo medicines may be effectively integrated into Western medicine.

Contents.—**1)** Introduction; **2)** Traditional usage and therapeutic indication; **3) Crude drugs I:** taxonomical items, collection and cultivation, production etc.; **Crude drugs II:** phytochemical studies of ingredients and analytical evaluation; **Crude drugs III:** structural transformation of ingredients; **Crude drugs IV:** pharmacological and biochemical studies of medicinal plants of Sho-saiko-to; **4)** Formulation 1: quality assessment, manufacturing technology and quality control of Sho-saiko-to extract formulation; Formulation 11: pharmacokinetics, toxicology and pharmacology of Sho-saiko to; **5)** Clinical studies; **6)** Recent topics on Sho-saiko-to and other Kampo medicines; and Index.

Biographical/Bibliographical

UNIVERSITY OF TENNESSEE PRESS

CHARLES BOEWE (ed.). 2003. **Profiles of Rafinesque.** (ISBN 1-57233-225-5, hbk.). University of Tennessee Press, Suite 110, Conference Center Building, Knoxville, TN 865-974-3321, U.S.A. (Orders: fax 865-974-3724, tpost@utk.edu, www.utpress.org). $45.00, 411 pp., 45 figs., 1 color plate, 5" × 9".

As a graduate student, Charles Boewe, editor of *Profiles of Rafinesque* "developed an extracurricular curiosity about C.S. Rafinesque." After reading this book one can easily understand the fascination for this multi-faceted, multilingual, maverick. Using a number of published essays by various writers (including himself) Boewe has compiled a compelling biography of Constantin Samuel Rafinesque and at the same time sketched a picture of the state of 19th century natural science.

In his introduction, the editor discusses the difficulties of finding decisive biographical material and depends on an address given by Francis W. Pennell in 1940 to supply the framework for an authentic account of the life. This interesting essay gives an overview of Rafinesque's work in an alphabet of scientific fields with excursions into banking and manufacturing. Another writer deals with his position as a field naturalist, taxonomist, and biological theoretician in terms of modern knowledge.

Rafinesque regarded himself primarily as a traveler and nothing he encountered was beyond his purview including the study of man. He was intrigued by the American Indians he met on his journeys, studied their languages and customs and endeavored to explain the mysterious Indian

mounds he saw. His contributions to ethnology and philology and the hoax of the *Walum Olum* are the subjects of a fascinating section.

Another part of the book is concerned with Rafinesque as a writer. There is a dissection of his two-volume *Medical Flora*. Another essayist pays tribute to him as a popularizer of botany—a trend in the 19th century—with his book *School of Flora*.

The final section contains an account by John James Audubon of Rafinesque's three week visit with him in Florida where Rafinesque collected "multitudes of plants, shells, bats, and fishes." And at the last Boewe clears up the mystery of where Rafinesque is buried, but not quite.

Each of the essays is self-contained. Together they offer a splendid biography of an intriguing character. The copious notes and 45 figures add to the value of this excellent work.—*Ruth Ginsburg, Botanical Research Institute of Texas, Fort Worth, TX, 76102 4060, U.S.A.*

MARY COKER JOSLIN with drawings by SANDRA BROOKS-MATHERS. 2003. **Essays on William Chambers Coker, Passionate Botanist.** (ISBN 0-9721600-0-0, hbk.). University of North Carolina at Chapel Hill Library and the Botanical Garden Foundation, Inc. (Orders: BGF Book Sales, c/o North Carolina Botanical Garden, Totten Center CB#3375, University of North Carolina, Chapel Hill, NC 27599-3375, U.S.A., 919-962-0522). $30.00, 197 pp., b/w photos, color photos, drawings, 6" × 9 1/4".

HOWARD GARRETT. 2003. **Dear Dirt Doctor: Questions Answered the Natural Way.** (ISBN 0-292-72847-6, pbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. (Orders 800-252-3206 512-471-4032, 800-687-6046 fax). $16.95, 240 pp., 5 1/2" × 8 1/2".

Howard Garret, Dallas/Fort Worth's champion of gardening without toxic chemicals, has revised and updated his 1995 *Dirt Doctor's Guide to Organic Gardening* to a fast-reading, fact-filled interaction between the Dirt Doctor and his personal bounty of garden knowledge and the plant woes and wisdom of his readers and talk show listeners. From the opening chapter on the common sense and economics of gardening organically to the closing on chasing off armadillos and mice with cayenne pepper powder (it worked on one smart marauding mouse in my house!), Mr. Garrett covers soil and bed preparation, compost, synthetic vs. natural fertilizers, pest control and beneficial insects, landscaping ideas and maintenance, trees, herbs, food crops, wildflowers, turf, and indoor houseplants. The coverage is attention-grabbing, not refried generalities. For instance, on mosquitoes a reader tip relates a New Delhi research report on using peppermint oil to repel the pest and kill its larvae I sprinkled my rainwater barrels with the oil immediately. It worked. On the subject of herbs, the opening paragraph touts cinnamon oil, garlic, clovers, oregano and sage as proven destroyers of even the most dangerous strains of *E. coli*. I have used this herbal paramedic squad for eight years to keep me out of a doctor's office. They deserve opening line prominence.

A grand salute is in order to Howard Garrett for a most impressive compilation of information—with but one caveat! There are rumblings of discontent in his cornmeal paradise (see page 71). Humalfa Corporation's website, www.hu-more.com advises against the use of cornmeal with its "Green Bag" product after disturbing results form the field. There is more research to be done on its effectiveness.—*Karen M. Foley, Fort Worth, Texas.*

BOOK REVIEWS/NOTICES/BOOKS RECEIVED

Environmental/Ecology/Conservation/Landscape Ecology

GREG GORDON. 2003. **Landscape of Desire.** (ISBN 0-87421-560-9, ppk.). Utah State University Press, 7800 Old Main Hill, Logan, UT 84322-7800, U.S.A. (Orders: 435-797-1362, Fax 435-797-0313). $19.95, 213 pp. 1 map, 6" × 9".

The old professor (AKA the old philosopher) takes a group of students from the Sierra Institute for a six weeks exploration of Utah's Canyon Country. He wants each person to experience the place "on a physical level" and develop a personal awareness of the environment." To help reinvent themselves as "they metamorphose from adolescence to adulthood," everyone takes a trail name. If the reader doesn't mind accompanying Sage, Yucca, Seeker, Bobofet, Seaweed, Metta, Mud, and Huckleberry, he can learn a great deal from this book. Gordon is extremely knowledgeable about the natural history and folklore of this magnificent country and describes it in a lively manner as the group descends through the 16 geologic formations of the San Raphael/Dirty region.

Another purpose of the trip is to document the abuse of the land by motorbikes and all terrain vehicles. This leads to the examination of the whole question of the conflict between development and preservation. It's no contest. Gordon is a disciple of Leopold and Abbey.

I missed maps and pictures.—*Ruth Ginsburg, Botanical Research Institute of Texas, Fort Worth, TX, 76102-4060, U.S.A.*

VACLAV SMIL. 2002. **The Earth's Biosphere: Evolution, Dynamics, and Change.** (ISBN 0-262-19472-4, hbk.). The MIT Press, 5 Cambridge Center, Cambridge, MA 02142-1493, U.S.A. (Orders: 800-405-1619, mitpress-orders@mit.edu, http://mitpress.mit.edu). $32.95, 346 pp., 138 illustrations, 8" × 9".

Contents.—**1)** Evolution of the Idea: From Vernadsky to a Science of the Global Environment; **2)** Life in the Universe: Attributes, Constraints, and Probabilities; **3)** Life's Diversity and Resilience: Metabolisms, Species, Catastrophes; **4)** Energizing the Biosphere: Solar Radiation and the Earth's Heat; **5)** Water and Material Flows: Biospheric Cycles, **6)** The Biosphere's Extent: The Moveable Boundaries; **7)** The Biosphere's Mass and Productivity: Quantifying Life's Presence and Performance; **8)** The Biosphere's Dynamics and Organization: Fundamental Rules and Grand Patterns; **9)** Civilization and the Biosphere: The Earth Transformed by Human Action; **10)** Epilogue; Appendixes; References; Scientific Name Index; Name Index; and Subject Index.

BRIAN ALEXANDER. 2003. **Rapture: How Biotech Became the New Religion.** (ISBN 0-7382-0761-6, hbk.). Basic Books, A Member of the Perseus Books Group, 387 Park Avenue South, New York, NY 10016, U.S.A. (Orders: 212-340-8100, www.basicbooks.com). $25.95, 256 pp., 6" × 9 1/4".

Contents.—**1)** Waiting for the Rapture; **2)** The Prophet; **3)** The Endless Frontier; **4)** Arise, Lazarus Long!; **5)** The Immortal Mr. Steinberg; **6)** Way Out West; **7)** Bring On the Inquisition Water into Wine; **9)** Pop! Goes the Rapture; **10)** The Rapture Rides in a Limo; Acknowledgments; Notes; and Index.

This book basically sheds light on the modern science of cloning, stem cells, miracle drugs, and genetic engineering.

ARTHUR MOLELLA and JOYCE BEDI (eds.). 2003. **Inventing for the Environment.** (ISBN 0-262-13427-6, hbk.). The MIT Press, 5 Cambridge Center, Cambridge, MA 02142-1493, U.S.A. (Orders: 800-405-1619, mitpress-orders@mit.edu, http://mitpress.mit.edu). $29.95, 398 pp., 49 illustrations, 7" × 9 1/4".

From the dustjacket.—"This ambitious book describes the many ways in which invention affects the environment (here defined broadly to include all forms of interaction between humans and nature). The book starts with nature itself and then leads readers to examine the built environment and the specific technologies in areas such as public health and energy."

Contents.—On Nature and Technology; What Role Does Innovation Play in Urban Landscapes? How do Innovations in City Planning Shape the Environment? How Do Innovations in Architecture Affect the Environment? How can Innovations in Alternative Energy Sources Affect the Environment; How are the Principles of Industrial Ecology Applied to Benefit the Environment; Conclusion: The New Environmentalism, and Index.

PAULO S. OLIVEIRA AND ROBERT J. MARQUIS (eds.). 2002. **The Cerrados of Brazil: Ecology and Natural History of a Neotropical Savanna.** (ISBN 0-231-12043-5, hbk.). Columbia University Press, 136 South Broadway, Irvington, NY 10533-2599, U.S.A. (Orders: 800-944-1844 fax, http://www.columbia.edu/cu/cup/). $29.95, 398 pp., 49 illustrations, 7" × 9 1/4".

Contents—**1)** Introduction: Development of Research in the Cerrados; **PART I.** Historical Framework and the Abiotic Environment; **2)** Relation of Soils and Geomorphic Surfaces in the Brazilian Cerrado; **3)** Late Quaternary History and Evolution of the Cerrados as Revealed by Palynological Records; **4)** The Fire Factor; **5)** Past and Current Human Occupation and Land-Use. **PART II.** The Plant Community: Composition, Dynamics, and Life-History. **6)** Vegetation Physiognomies and Woody Flora of the Cerrado Biome; **7)** Herbaceous Plant Communities; **8)** Patterns and Dynamics of Plant Populations; **9)** The Role of Fire in Population Dynamics of Woody Plants; **10)** Ecophysiology of Woody Plants. **PART III.** The Animal Community: Diversity and Biogeography. **11)** Lepidoptera in the Cerrado Landscape and the Conservation of Vegetation, Soil, and Topographical Mosaics; **12)** The Character and Dynamics of the Cerrado Herpetofauna; **13)** The Avifauna: Ecology, Biogeography, and Behavior; **14)** The Cerrado Mammals: Diversity, Ecology, and Natural History. **PART IV.** Insect Plant Interactions. **15)** Ant Foraging on Plant Foliage: Contrasting Effects on the Behavioral Ecology of Insect Herbivores; **16)** Interactions Among Cerrado plants and Their Herbivores: Unique or typical? Robert J. Marquis; **17)** Pollination and Reproductive Biology in Cerrado Plant Communities. **PART V.** The Conservation of the Cerrados. **18)** Biodiversity and Conservation Priorities in the Cerrado Region; Index.

SARA OLDFIELD. 2002. **Rainforest.** (ISBN 0-262-15106-5, hbk.). The MIT Press, 5 Cambridge Center, Cambridge, MA 02142-1493, U.S.A. (Orders: 800-405-1619, mitpress-orders@mit.edu, http://mitpress.mit.edu). $29.95, 160 pp., 200 color illustrations, 9 1/2" × 12 1/2".

This book is a great reminder of the incredible beauty and diversity of rainforests around the world. The stunning photography is by Bruce Coleman Collection. Review forthcoming in Sida 21(1), 2004.

LOREN M. SMITH. 2003. **Playas of the Great Plains.** (ISBN 0-292-70177-2, pbk; 0-292-70534-4, hbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A., (Orders: 800-252-3206, 800-687-6046 fax). $24.95 (pbk), $60.00 (hbk), 264 pp., 34 b/w illustrations, 6" × 9".

This book is about wetland ecology and conservation of the Playas of the High Plains. There are eight chapters broken down under three main sections; **Playas and their Environment: 1)** What is a Playa?; **2)** Origin and Development. **Ecosystem Aspects: 3)** Flora; **4)** Fauna; **5)** Structure, Function, and Diversity. **Conservation Aspects: 6)** Historical, Cultural, and Current Societal Value of Playas; **7)** Threats to Proper Function of Playas; **8)** Conservation Past, Present, and Future; Appendix; References; Index.

JAMES A. YOUNG and CHARLIE D. CLEMENTS. 2002. **Purshia: The Wild and Bitter Roses.** (ISBN 0-87417-491-0, hbk.). University of Nevada Press, Mail Stop 166, Reno, NV 89557-0076, U.S.A. (Orders: 775-784-6573 x232, 775-784-6200 fax, www.nvbooks.nevada.edu). $39.95, 280 pp., 35 b/w photos, 4 illustrations, 3 maps, 6" × 9 1/4".

The genus *Purshia* is in the family Rosaceae. The book is an indepth look at the ecology and management of habitat for these important species of plants that form a vital component of the western and intermountain vegetation. Twelve chapters discuss everything from the historical aspects of the wild and bitter roses to bitterbrush plant communities to insects and plant diseases to management issues related to *Purshia* species. The text is supplemented with line drawings and photographs.

Plant Physiology/Plant Anatomy/Pathology/Agriculture

RICHARD C. KEATING. 2003. **Anatomy of the Monocotyledons. IX Acoraceae and Araceae.** (ISBN 0-19-850122-6, hbk.). M. GREGORY and D.F. CUTLER (eds.). Oxford University Press. (Orders: Oxford University Press, 2001 Evans Road, Cary, NC 27513, U.S.A., 800-451-7556, 919-677-1303 fax, www.oup.com). $125.00, 327 pp., 855 photomicrographs in 115 plates, 7 1/2" × 9 1/2".

This is volume nine in the continuation of the series *Anatomy of the Monocotyledons*. Based upon anatomical, morphological, and molecular data, a new classification system of the Araceae is presented.

BOOK NOTICES
IOWA STATE PRESS
(A BLACKWELL PUBLISHING COMPANY)

KRISTINA BOONE, TERRY MEISENBACH, and MARK TUCKER. 2003. **Agricultural Communications: Changes and Challenges.** (ISBN 0-8138-2167-3, pbk.). Hardback (1st) edition 2000. Iowa State Press, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax; www.iowastatepress.com). $29.99, 144 pp., b/w photos and other illustrations, 6" × 9".

PETER F. FFOLLIOTT, LUIS A.BOJORQUEZ-TAPIA, and MARIANO HERNANDEZ-NARVAEZ. 2003. **Natural Resources Management Practices: A Primer.** (ISBN 0-8138-0913-4, pbk.). Hardback (1st) edition 2001. Iowa State Press, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax; www.iowastatepress.com). $34.99, 256 pp., illustrations, 6" × 9".

CHARLES B. MOSS and ANDREW SCHMITZ. 2003. **Government Policy and Farmland Markets: The Maintenance of Farmer Wealth.** (ISBN 0-8138-2329-9, hbk.). Iowa State Press, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax; www.iowastatepress.com). $59.99, 432 pp., tables and graphs, 6" × 9".

The book has 21 chapters that addresses farmland values and is divided into six sections: **Section I:** Historical Perspectives on Farmland Values; **Section II:** Government Policies and Farmland Values; **Section III:** Capital Markets and Farmland Values; **Section IV:** Transaction Costs and Farmland Values; **Section V:** Urbanization, Environmental Quality, and Farmland Values; **Section VI:** Regional and International Dimensions.

COLIN G. SCANES and JOHN A. MIRANOWSKI. 2004. **Perspectives in World Food and Agriculture: 2004.** (ISBN 0-8138-2021-9, hbk.). Iowa State Press, 2121 State Avenue, Ames, IA 50014, U.S.A. (Orders: 1-800-862-6657, 1-515-292-3348 fax; www.iowastatepress.com). $69.99, 485 pp., tables, graphs, drawings, 6" × 9".

Perspectives in World Food and Agriculture: 2004, written by a team of international researchers, scientists, and academics, is about global agriculture. It brings together cutting-edge agricultural research in 25 chapters, in six broad sections: **Section I:** Frontiers in World Food; **Section II:** Frontiers in Food; **Section III:** Frontiers in Animal Agriculture; **Section IV:** Frontiers in Water; **Section V:** Frontiers in Policy and Ethics; **Section VI:** Statistics and Trends in World Agriculture.

BOOK REVIEWS

DOROTHY HINSHAW PATENT. Photographs by WILLIAM MUÑOZ. 2003. **Plants on the Trail with Lewis and Clark.** (ISBN 0-618-06776-0, hbk.). Clarion Books, a Houghton Mifflin Company imprint, 215 Park Avenue South, New York, NY 10003, U.S.A. (Orders: http://www.houghtonmifflinbooks.com/catalog/titledetail.cfm?titleNumber=111018). $18.00, 112 pp., color, b/w photos, 8" × 10".

This companion to Animals on the Trail with Lewis and Clark (Clarion 2002) by Patent and Muñoz traces Lewis' and Clark's epic journey citing useful plants along the way and many of the plants they introduced to science. Though specifically written for children in grades 4 – 8, the interesting text and beautiful photographs make this book an enjoyable read for anyone wanting to know more about the importance of plants to the success of the expedition.

The book opens with a beautiful two-page map that highlights the route of the explorers from St. Louis in the midwest to Fort Clatsop on the Pacific Ocean, showing camps and landmarks along the way. Lewis and Clark took this 2000-mile route with a crew of about 40 men with orders from President Thomas Jefferson to find a navigable river passage across North America, describe, map and explore the unknown region, discuss peaceful trade with Indian tribes and investigate and record the soils, plants and animals they encountered on the journey. Patent and Muñoz do an excellent job of helping the reader understand how plants were used by members of the Expedition and Lewis,' and Clark's role in documenting these plants, many of which were new to science. The book discusses the importance of trees to the explorers' success from providing wood for the keelboat and pirogues to take the Expedition upriver, to supplying fuel for their many campfires. Patent also describes the plants used as food and medicine along the way, often citing the Indian tribe that introduced the Discovery members to various new sources of vitamins or remedies. Excerpts from Lewis' and Clark's journals throughout these chapters help the reader understand these leaders' reactions to seeing unfamiliar plants and landscapes for the first time or experiencing new plants as foods. Muñoz's striking color photographs on nearly every page spotlight examples of individual plants important to the expedition and scenic views along the trail, and they give the reader glimpses of the beautiful vistas the members of the Corps of Discovery must have witnessed on their incredible journey.

A final section discusses the fate of the specimens collected by Meriwether Lewis with color photographs of several select specimens. Patent explains Frederick Pursh's role in describing, illustrating and naming the plants collected on the expedition. Appendices include a recommended list of other books and websites regarding the Lewis and Clark Expedition, and a list of the surviving plants in the Lewis and Clark Herbarium at the Academy of Natural Sciences in Philadelphia with information on each specimen's date and location of collection.

This book provided me with a great deal of helpful information that I use in our school pro gram and teacher workshop "The Lewis and Clark Expedition Through the Eyes of Art and Science." The focus of this program is on the botanical explorations of Lewis and Clark, and I have sought many sources for background information on the specimens collected by Lewis and Clark and the importance of plants on the expedition. This book alone provided more helpful information than many sources combined.—*Amber Keller, Coordinator of School Services, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A., akeller@brit.org.*

PAUL MARTIN BROWN. 2002. **Wild Orchids of Florida, with References to the Atlantic and Gulf Coastal Plains.** (ISBN 0-8130-2439-0, pbk.). University Press of Florida, 15 Northwest 15th St, Gainesville, FL 32611-2079, U.S.A. (Orders: www.upf.com, 800-226-3822). $24.95, 428 pp., 447 color photos, 135 b/w illus., 6" × 9".

PAUL MARTIN BROWN. 2003. **The Wild Orchids of North America, North of Mexico.** (ISBN 0-8130-2571-0, pbk.). University Press of Florida, 15 Northwest 15th St, Gainesville, FL 32611-2079, U.S.A. (Orders: www.upf.com, 800-226-3822). $27.95, 256 pp., 295 color photos, 247 b/w illus., 6" × 9".

The appeal of orchids, and books about orchids, hardly requires explanation to anyone who has ever admired or desired these plants. Even common orchids manage to maintain an air of elegant and exotic (or erotic) mystery. The name Paul Martin Brown should be well known to American orchid fanatics. He is the founder and editor of the *North American Native Orchid Journal*, and has published several previous field guides on orchids. Most recently, he was a major contributor to the Orchidaceae treatment in Volume 26 of *Flora North America*. Brown has produced two exemplary orchid field guides, for North America and for Florida, with profuse color photographs and excellent illustrations by Stan Folsom.

Wild Orchids of Florida covers 118 species and varieties, 26 growth/color forms, and 6 hybrids. Approximately half the orchid species in North America are found in Florida. The book begins with some information not typically found in field guides, including a history of orchid work in Florida, a chapter about orchids in general (morphology, habit, habitat), and a section on how to use a dichotomous key. The last is something that should definitely be included in any similar technical works with such a wide and general appeal. Following this introduction, a key to the genera of orchids in Florida is provided and supplemented with illustrations of some important couplet characters. Brief explanations are then given concerning the logic behind scientific names; the vagaries of common names; variations in size, color, and flowering time; and range map use. A map of Florida is provided, with all counties labeled.

The orchids themselves are divided into two sections: native and naturalized species, followed by introduced, escaped, or waif species. Within these sections, genera and species are in alphabetical order. Each genus is introduced by a general description and statement of range beyond Florida, and a key is given to the species, if more than one is found in the state. Each species is then treated with nearly a full page of text, listing the Latin name, common name, world range, range within Florida (frequently including status, if threatened or endangered), a description of the plant (habit, leaves, and flowers) including size ranges, habitat, and flowering period. This is followed by an entertaining paragraph containing notes of interest, which may include more information on the habitat or rarity of the species, life history, nomenclatural history, or a discussion of morphological variation within that species over a geographic range. Also on this page is a pen-and-ink illustration of the (usually) entire plant, and a Florida range map, with one dot in each county the species has been recorded. The illustrations generally depict the entire habit of the plant, including basal leaves, and are detailed enough so that most species could be identified by these drawings alone. The facing page is full of various color photos showing entire plants or populations of each species, plus close ups of inflorescences and flowers or fruits. A few poor-quality photographs do not detract from the beauty or utility of this book.

A final section entitled "Resources and References" provides a great deal of useful information, including a simple checklist of all taxa, recent literature references (listed by species), synonyms

and misapplied names, and statistics on endangered and endemic orchid species in Florida. An interesting chapter called "Orchid Hunting in Florida" divides the state into regions, and then for each region provides a discussion of habitats and a list of species. A special chapter that can be used outside of Florida, but still within the Gulf Coastal Plains of the southeastern USA, lists all extra-Floridian orchid species and their ranges. The very brief glossary will probably require supplementation from a botany text for many users of the keys. Other than this, *Wild Orchids of Florida* is a perfect field guide, with keys that will allow the identification of an orchid in-hand. Inversely, this book has enough supplementary information that a reader can probably select a (relatively common) orchid species from the book, and then go and successfully find it in the wild. Beyond these uses, the notes on each species make for entertaining armchair reading, and the photos are so enjoyable that any Floridian (and any other orchid fanciers) would be glad to own this book.

The Wild Orchids of North America covers 223 species, 24 subspecies and varieties, 103 growth/color forms, and 24 hybrids. The checklist is arranged alphabetically by genus and species. Hybrids are listed at the end of each genus. Generally, there are two species per page. Each species entry gives the Latin name and authority, synonyms and misapplied names, common name, general range, list of subspecific forms if any, references, and a brief comment about the plant's morphology, rarity, or preferred habitat. Non-native species are indicated with an asterisk next to the Latin name. Each species is illustrated with a pen-and-ink drawing and a color photograph. The photos are excellent and usually show a close-up of the flower or inflorescence. However, neither the photos nor the drawings have indications of scale, and nothing about the size of the plants or flowers is given in the species descriptions.

My main complaint about this section of the book is the layout of the text. In an effort to take up a minimum amount of page per entry, not enough space has been allowed between each element (synonyms, range, references, comment) and some lines are indented in a confusing fashion. Final comments for each species are in statement form, rather than in sentences, and begin without a capitalized first letter, causing these to visually run into the previous element in a distracting way. For many species, no references at all are given; for others, three or more are listed. The introduction's encouragement to orchid enthusiasts to seek out these plants (hopefully just for photographs) is somewhat blunted by the lack of any habitat information at all for many of the species portrayed. Following the main list of species, a shorter section contains color photos of some of the forms or hybrids already listed in the front section of the book. The next chapter contains technical keys to all the orchid genera and species in North America. The appendices include a list of excluded species, and errata for Carlyle Leur's classic works *The Native Orchids of Florida* (1972) and *The Native Orchids of the United States* (1975). The glossary is handy, but is missing some terms used in the keys, such as flabellate, pedicel, and rostellum. The term peduncle is misdefined as " the stalk of a flower or leaf," when it is in fact the stalk of an inflorescence. Following the bibliography, a personal checklist section is provided for those working on their "life list." The North American orchid book will be handy for someone who has found an orchid and would like to identify it but does not desire much more information beyond the correct name of the species. It is also an entertaining book to browse for the sake of the photographs, and could be used to familiarize oneself with the genera of North American orchids.

Both books are durably "flexibound," and the fold-out endpages have useful metric and English rulers on their margins.—*Amanda K. Neill, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., aneill@brit.org.*

JENS E. MADSEN, ROBERT L. MIX, and HENRICK BALSLEV. 2001. **Flora of Puná Island: Resources on a Tropical Island.** (ISBN 87 7288 854 7, pbk.). Aarhus University Press, Langelandsgade 177, DK-8200 Aarhus N, Denmark. (Orders: www.unipress.dk, +45/89-42-53-80 fax). $39.95, 289 pp., 35 color photos, 10 b/w illus., 6 3/4" × 9 1/2".

Puná Island is situated in the Pacific Ocean near the equator, in the gulf of Guayaquil in Ecuador. Though only 3 km from the coast, the small (855 sq. km) island has a flora rich in near-endemic species. Puná Island also has an interesting cultural history of early human occupation (5000 BC), however, the island's natural vegetation has remained fairly unaltered compared to the mainland. This island contains a well-preserved remnant of tropical dry forest—an extremely endangered habitat with less than 1% remaining in the neotropics.

The text begins with an introduction to Puná Island: the geography, climate, sociology, and history of the region, including details on early exploration of the island, botanical and otherwise. The second chapter addresses the vegetation of the island, which is primarily *matorral*, or thorny deciduous forest. Seven principal plant communities are described, including mangroves, salt marshes, savannas, thorn scrubs, and dry forests, with principal plants named for each community. The thorn forest, the most widespread community on the island, is also described with quantitative structural and compositional data gathered from studies conducted in a permanent 1-hectare plot. Trees greater than 5 cm DBH (diameter at breast-height) were identified and measured. The plot was found to contain half the tree species on the entire island, with the families Bombacaceae and Bignoniaceae being most abundant. A six-year study of forest dynamics and phenology is discussed.

The third chapter summarizes the flora of Puná Island, which shows floristic similarities to the Andes and to the Galapagos Islands. This region encompasses what is known as the *Guayas center of plant endemism*—the area west of the Andes between southern Colombia and northern Peru. The native and naturalized flora of the island comprises 428 species of vascular plants; of this, 15 % of the plant species are endemic to the Guayas center. As in many floras throughout the world, the most specious families are the Fabacese, Poaceae, and Asteraceae. No species are endemic to the island itself, though rare and unusual plants are found there. Roughly 29% of the species on Puná Island are shared with the Galapagos Islands, nearly 800 km to the west. At least 14% of the species on Puná Island were introduced directly or indirectly by man and his domesticated animals. The plants used by the people on Puná Island are discussed in the fourth chapter. Archaeological evidence is given for early agricultural crops (maize, cassava, pumpkin, sweet potatoes, peppers, and cotton) as well as early tree crops (sweetsop, guava) in use in Pre-Columbian times. The early colonial period brought introductions of Old World species such as lime, melon, and sugar cane. Much detail is given concerning the use of many species for lumber in shipbuilding over the past few centuries. An ethnobotanical and linguistic study of modern plant use and plant names on Puná Island fills the rest of this chapter, with lists and discussions of edible plants, poisonous plants, useful woods, and miscellaneous uses such as dyes and soaps.

The bulk of this text is filled with keys and descriptions of all the species in the flora. This is organized by family, genus, and species. Descriptions are brief and include human uses, vernacular names, and information on nativity and distribution, as well as voucher specimen citations. Plants are not illustrated. There is no checklist as such, but there is an index in which the italicized Latin names stand out, and the description section is well-spaced and browseable. A separate index to places and historic people follows the plant index. A central section of the book groups the color photo plates of various habitats and a few plant species of ethnobotanical interest. The endpapers of the book display colored maps of Puná Island, one combining physical, political, and natural features, and one defining major plant communities. This book successfully builds upon the standard flora

format by including historical and ethnogeographical data. This book will be of interest to any who wish to learn about Pre-Columbian human occupation of coastal Ecuador, neotropical ethnobotany, and early South American agricultural practices. However, if the reader is comfortable using technical keys without illustrations, *The Flora of Puná Island* will primarily be a very useful fieldbook that can be used to identify plants anywhere in the coastal region of Ecuador.—*Amanda K. Neill, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., aneill@brit.org.*

BERTIL NORDENSTAM, GAMAL EL-GHAZALY, and MOHAMED KASSAS (eds). 2000. **Plant Systematics for the 21st Century: Proceedings from a symposium held at the Wenner-Gren Centre, Stockholm, in September 1998.** (ISBN 1-85578-135-2, hbk.). Wenner-Green International Series, Vol. 77. Portland Press Ltd., 59 Portland Place, London W1B 1QW, U.K. (Orders: +44-020-7580-5530, editorial@portlandpress.com, North American orders to: Princeton Univ. Press, 41 William St. Princeton, NJ 08540, U.S.A.). $120.00, 376 pp., numerous b&w drawings, charts, and halftones, 6 3/4" × 9 1/2".

The august title, "Plant systematics for the 21st century," may capture many purchasers for this book. If so, the readers will be soundly disappointed with their acquisition. This is not to say there are not many useful and insightful contributions; there are. But taken together, these collected papers do not fulfill the promise of the title.

In actuality, this is a festschrift for two prominent and influential Swedish botanists, Vivi Laurent-Täckholm and Gunnar Edrtman, who would have been 100 years old at the time of the symposium. Notice the more accurate characterization found in the introduction:

"In choosing the themes of the symposium we planned to give an overview of the fields of these two scholars, namely plant systematics and palynology. In addition to commemorating and remembering the contributions of Täckholm and Erdtman, we also wished to summarize current knowledge in these fields. We also aimed to include new information on some related and expanding research areas of great biological interest and significance, such as aspects of anatomy and floral odours."

Five papers are biographical. As commemorations of the contributions of Erdtman and Täckholm, respectively, six papers discuss advances in palynology, while four summarize recent studies in the flora of Egypt. Six more papers deal with current issues in plant systematics including limits to computer analysis and nomenclatural challenges. Four papers examine new techniques that have been applied to problems in particular families or orders. Finally the last paper records the panel discussion used to wrap up the symposium.

Many of the biological papers are case studies of the application of new methods to plant systematics, even the overview papers. A good example is Prance's paper on the changing focus of research on the Chrysobalanaceae over the last 40 years. Even Källersjö and Farris' paper serves primarily to highlight the contribution of Farris' computer algorithm on parsimony jackknifing. Probably the best overviews of research advances are El-Ghazaly's paper on new methods in palynology, Ferguson's paper on application of pollen morphology in systematics, and Chanda's comments on the application of palynology to understanding related fields.

While all the biological papers are excellent summaries of new methods and application of those methods over the closing decades of the 20th century, only two are truly forward looking. Kubitzki's contribution reviews the state of plant systematics. He tries to foresee the future trends in cladistic and molecular analysis, conflicting data, and information technology. Greuter is concerned for the future of plant nomenclature and the challenge to provide stable names for species and higher taxa as global conservation becomes an increasingly important goal for biologists.

The panel discussion disappoints one looking for the future prospects of plant systematics. It comes as no surprise that nearly all the speakers agreed that the top three priorities should be 1) documentation of the world's biodiversity before it is irreversibly lost, 2) conservation of that biodiversity, and 3) continued research to better understand evolutionary mechanisms. Some of the speakers mentioned increasing and improving herbarium and biological databases and retrieval. However, no room was given to developing models on how the greatly expanded databasing should be achieved. Indeed the only other reference to this important issue was a couple of paragraphs in Kubitzki's paper.

Surprisingly, I found very little on the next phase for molecular biology. That is, moving from a simplistic comparisons of nucleotide sequences in a few analyzable genes to understanding the underlying genetics of integrated character complexes of expressed phenotypes. Indeed, in Kubitzki's assessment I found just the opposite, "To this end [of interpreting character evolution] morphological or other traits can be mapped onto cladograms, which should preferably be based on molecular data." While I understand his concern of avoiding circular reasoning by using alternate data sets, I see a problematic attitude that is developing in systematics, even among the traditional morphologically oriented researchers. Are we (as a biosystematics community) to form our classifications on one or a few genes and force the interpretation of morphological characters, many of which derive from highly correlated multi-gene complexes, onto those simple gene trees? Are we falling headlong again into the trap of "one character taxonomy?" Perhaps we should be more prudent, realizing that these highly sophisticated, but philosophically simplistic methods are not showing us phylogenetic history any more than do the confusingly homoplastic morphological methods.

While this book falls short of its purported goal, nonetheless it is a valuable collection of articles. It is worth owning, especially for accessing the literature on palynology, Egyptian botany, nomenclature, and various modern systematic techniques.—*Roger W. Sanders, Associate Collections Manager, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., rsanders@brit.org.*

MARK BONTA. 2003. **Seven Names for the Bellbird: Conservation Geography in Honduras.** (ISBN 1-58544-249-6, hbk.). Texas A&M University Press, John H. Lindsey Bldg., Lewis St., 4354 TAMU, College Station, TX 77843-4354, U.S.A. (Orders: 1800-826-8911, w-lawrence@tamu.edu, www.tamu.edu/upress). $35.00, 250 pp., 35 b&w photos, 4 maps, 5 3/4" × 9 1/4".

Within the text, Mark Bonta takes an ethnographic approach to understanding the relationship between the local people of Honduras and the birds of their region, thus serving to create a bridge between academic geography and what he calls "on-the-ground conservation." The recounting of this approach and its results takes the form of individual and family histories and stories relayed throughout the text. The particular intent of the text is to dissuade the reader that humans are entirely destructive with a conscious purpose, and that in particular the relationship between Honduran locals and their avifauna is not inherently detrimental to the birds. However, Bonta does not parade his findings as assurance that the birds have a secure place in the Neotropical landscape.

The text is divided into nine separate chapters, preceded by an introduction to conservation geography, as it will be dealt with for the remainder of the text, and succeeded by an appendix listing the birds recorded for the central Olancho department of Honduras as well as a glossary of Spanish terms. The first chapter delves into the subject of "ornithophilia" (a natural love for birds) through the depiction of a young girl, Lucita, and her interaction with the birds in her area. As a standard for

chapters dealing with personal histories, Bonta further divides each into sections, the first few serving as stand-alone examples of what in the latter sections he takes apart and reflects on in his own voice.

Chapter two establishes the geographical and historical background of the region and its bird population, acknowledging these features as among the most important contributors to the varying relationships with birds. Chapter three takes into account that Honduras is a male-dominated society and the more obvious facets of relationships with birds are not the only ones; women and children are given voices to share their perceptions of the issue. Chapter four lays bare the situation within Juticalpa, an urban center in Olancho, using case studies of two birds, the *zopilote* (Black Vulture) and the *zorzal* (Clay-colored Robin). Chapter five brings up the capacity in which large landowners act as conservationists, contrary to general expectation. Chapter six presents the other side of chapter four, highlighting the rural landscape of small domestic and individual villages and farmers, where biodiversity is highest and may be most easily conserved. Chapter seven exposes Honduras as a country where the majority of soil cover is not rainforest, and where many species requiring the attention of conservationists do not make their homes in virgin rainforest. Other marginalized species are also dealt with, such as those that are nocturnal. Chapter eight is a case study centered about the montane rainforest of Montaña de Babilonia. In chapter nine Bonta presents several proposals regarding the conservation geography of Honduran avifauna, with the intent for broader applications.

Perhaps the message which Bonta intends be taken home is that the destruction in the Neotropics is not accomplished with clear and purposeful intent, but rather as a side effect of certain socio-economic factors. Therefore, to lessen its impact, we must take a "geographical approach to conservation that cuts across artificial boundaries separating what is 'natural' from what is 'cultural' in the landscape" (p.3). While the theme of conservation geography is implied throughout the book, it is only in the last chapter where it is dealt with directly, and where it ceases to merely be an "ethnography of birds." The book does not resort to scientific and technical terms and therefore is easily understood; it is for a general audience interested in avifauna, conservation, and the idea of a "cultural landscape."—*Tiana Franklin, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., tfranklin@brit.org.*

PAUL E. MINNIS (Ed.). 2003. **People and Plants in Ancient Eastern North America.** (ISBN 1-58834-133-X, pbk.). Smithsonian Institution Press, 750 Ninth Street NW, Suite 4300, Washington, DC 20560-0950, U.S.A. (Orders: 202-275-2300, http://www.sipress.si.edu/). $34.95, 423 pp., 25 figs., 45 tables, 6" × 9".

This text is presented as the first in a two-volume set, consisting of eight chapters by contributing North American anthropologists. Minnis chooses to extend the time frame of ethnobotany to the past, and therefore deal with methods of paleoethnobotany. Using these methods, the contributing authors delve into three subject areas: prehistoric use of plants, crop history and applications, and human impacts on local environments. This first volume is loosely contained by geographical boundaries into, as the title indicates, an overview of Eastern North America; its fellow, as yet unpublished, will cover the remaining Western North American region.

In a sixteen-page introduction, Minnis provides an historical overview of the field of paleoethnobotany, quite easily explained for those of us that may have little use for such long-strung terms. Following this are chapters that concentrate on the Central and Southern Woodlands (about which much work has been done in the past), native plant use, crop domestication and food production, anthropogenic ecology, and regional concentrations in the Northeast, the Great Plains, and in the Caribbean Islands.

While it may be implied that the only data set for the conclusions drawn in the text consists of micro- and macro-botanical remains, this is not entirely the case. In the foreword, Minnis clearly establishes that along with botanical remains, such things as ancient field distribution and plant images in art can be used to infer ancient ethnobotanical relationships. The contributing authors present their portions particularly well although, having worked with botanists but not belonging to the discipline themselves, tend to generalize and lump various evidences unto one name, whereas in botanical nomenclature, 'fruit' would be inadequate and demand further explanation.

This compilation reads surprisingly well and holds interesting and significant information for the concerned environmentally-minded reader, bringing attention to issues such as the fact that the majority of human food supply is derived from a play of only 20 crops, whereas paleoethnobotanical evidence uncovers a suite of tens of thousands of crops cultivated in the past.—*Tiana Franklin, Botanical Research Institute of Texas, 509 Pecan St, Fort Worth, TX 76102-4060, U.S.A., tfranklin@brit.org.*

BIENNIAL REPORT AND UPDATE 2002–2003

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To all authors, we thank you for choosing *Sida, Contributions to Botany* as your forum to disseminate information and knowledge gained by scientific inquiry. Volume 20 represents the largest volume of SIDA ever published. SIDA is published twice a year with each issue seemingly increasing in size and in diversity of quality papers. Volume 20 has 1836 pages, 202 authors, 165 published contributions, and includes 229 new names and new combinations. Published papers are available online in Adobe Acrobat format (PDF files); the PDF files are true representations of the hard copy of SIDA. <*http://www.brit.org/sida/SCBCurIssue.htm*>.

A word of thanks to the 228 individuals acknowledged on pages 1793–1794, who generously supported SIDA through their time and expertise in reviewing approximately 188 manuscripts submitted for volume 20. All manuscript submissions are peer-reviewed by distinguished reviewers; your support is deeply appreciated. If by chance you reviewed a manuscript and your name was left out, the error rests solely on the shoulders of this editor and I truly apologize. Please bring any omissions to my attention.

Below are the dates of publication for each of the four issues of volume 20, subscriptions for calendar year 2004, and distribution of SIDA. We also bring to your attention (see page 1792) the *Mary M. Hennen Scientific Publications Endowment*, established to provide support to the future of BRIT's scientific publication program (*Sida, Contributions to Botany* and *Sida, Botanical Miscellany*). The index to volume 20 (2002–2003) follows and the issue concludes with a printed copy of the current guidelines to contributors. The online version is at *http://www.brit.org/sida/SubmitPaper.htm*.

We thank all authors, reviewers, subscribers (individuals, institutions, organizations), and readers for your continued interest and support. It is our plan to continue bringing you the best sources of current research in classical and modern systematics with your continued support. Wishing you the best in 2004 and beyond.—**Barney Lipscomb** (BRIT), Editor; **John W. Thieret** (NKU), Associate Editor; and **Félix Llamas** (LEB), Contributing Spanish Editor.

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Acleisanthes lanceolata var. **megaphylla** (Fowler & B.L. Turner) Spellenb. & J. Poole, comb. nov.—**20(3):**886

Agave ovatifolia Starr & Villarreal, sp. nov.—**20(2):**495

Ardisia nigrescens subsp. **donnellsmithii** (Mez) Ricketson & Pipoly, comb. et stat. nov.—**20(4):1431**

Ardisia verdisepala Ricketson & Pipoly, sp. nov.—**20(4):1435**

Arida D.R. Morgan & R.L. Hartman, comb. et stat. nov.—**20(4):1410**

Arida arizonica (R.C. Jackson & R.R. Johnson) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1413**

Arida blepharophylla (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1413**

Arida carnosa (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1413**

Arida coulteri (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1414**

Arida crispa (T.S. Brandegee) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1414**

Arida mattturneri B.L. Turner & G. Nesom, sp. nov.—**20(4):1418**

Arida parviflora (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1414**

Arida riparia (Kunth) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1414**

Arida turneri (M.L. Arnold & R.C. Jackson) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1414**

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Crataegus okanaganensis var. **wellsii** J.B. Phipps & O'Kennon, var. nov.—**20(1):**132

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Dichanthelium aciculare subsp. **fusiforme** (Hitchc.) Freckmann & Lelong, comb. & stat. nov.—**20(1):**167

Dichanthelium aciculare subsp. **neuranthum** (Griseb.) Freckmann & Lelong, comb. & stat. nov.—**20(1):**167

Dichanthelium acuminatum subsp. **columbianum** (Scribn.) Freckmann & Lelong, comb. & stat. nov.—**20(1):**167

Dichanthelium acuminatum subsp. **fasciculatum** (Torr.) Freckmann & Lelong, comb & stat.. nov.—**20(1):**167

Dichanthelium acuminatum subsp. **implicatum** (Scribn. ex Nash) Freckmann & Lelong, comb. & stat. nov.—**20(1):**167

Dichanthelium acuminatum subsp. **leucothrix** (Nash) Freckmann & Lelong, comb. & stat. nov.—**20(1):**167

Dichanthelium acuminatum subsp. **lindheimeri** (Nash) Freckmann & Lelong, comb. & stat. nov.—**20(1):**168

Dichanthelium acuminatum subsp. **longiligulatum** (Nash) Freckmann & Lelong, comb. & stat. nov.—**20(1):**168

Dichanthelium acuminatum subsp. **sericeum** (Schmoll) Freckmann & Lelong, comb. & stat. nov.—**20(1):**168

Dichanthelium acuminatum subsp. **spretum** (Schult.) Freckmann & Lelong, comb. & stat. nov.—**20(1):**168

Dichanthelium acuminatum subsp. **thermale** (Bol.) Freckmann & Lelong, comb. & stat. nov.—**20(1):**168

Dichanthelium sect. **Angustifolia** (Hitchc. in B.L. Rob. & Fernald) Freckmann & Lelong, stat. nov.—**20(1):**166

Dichanthelium chamaelonche (Trin.) Freckmann & Lelong, comb. nov.—**20(1):**168

Dichanthelium chamaelonche subsp. **breve** (Hitchc. & Chase) Freckmann & Lelong, comb. & stat. nov.—**20(1):**168

Dichanthelium sect. **Clandestina** Freckmann & Lelong, sect. nov.—**20(1):**164

Dichanthelium commutatum subsp. **ashei** (G. Pearson ex Ashe) Freckmann & Lelong, comb. & stat. nov.—**20(1):**169

Dichanthelium commutatum subsp. **equilaterale** (Scribn.) Freckmann & Lelong, comb. & stat. nov.—**20(1):**169

Dichanthelium commutatum subsp. **joori** (Vasey) Freckmann & Lelong, comb. & stat. nov.—**20(1):**169

Dichanthelium dichotomum subsp. **lucidum** (Ashe) Freckmann & Lelong, comb. & stat. nov.—**20(1):**169

Dichanthelium dichotomum subsp. **mattamuskeetense** (Ashe) Freckmann & Lelong, comb. & stat. nov.—**20(1):**169

Dichanthelium dichotomum subsp. **microcarpon** (Muhl. ex Elliott) Freckmann & Lelong, comb. & stat. nov.—**20(1):**169

Dichanthelium dichotomum subsp. **nitidum** (Lam.) Freckmann & Lelong, comb. & stat. nov.—**20(1):**169

Dichanthelium dichotomum subsp. **roanokense** (Ashe) Freckmann & Lelong, comb. & stat. nov.—**20(1):**170

Dichanthelium dichotomum subsp. **yadkinense** (Ashe) Freckmann & Lelong, comb. & stat. nov.—**20(1):**170

Dichanthelium sect. **Ensifolia** (Hitchc.in B.L. Rob. & Fernald) Freckmann & Lelong, stat. nov.—**20(1):**166

Dichanthelium ensifolium subsp. **curtifolium** (Nash) Freckmann & Lelong, comb. & stat. nov.—**20(1):**170

Dichanthelium sect. **Lancearia** (Hitchc.in B.L. Rob. & Fernald) Freckmann & Lelong, stat. nov.—**20(1):**166

Dichanthelium sect. **Lanuginosa** (Hitchc. in B.L.Rob. & Fernald) Freckmann & Lelong, stat. nov.—**20(1):**166

Dichanthelium sect. **Linearifolia** Freckmann & Lelong, sect. nov.—**20(1):**164

Dichanthelium sect. **Macrocarpa** Freckmann & Lelong, sect. nov.—**20(1):**165

Dichanthelium sect. **Nudicaulia** Hitchcock & Chase ex Freckmann & Lelong, sect. nov.—**20(1):**165

Dichanthelium sect. **Oligosantha** (Hitchc. in B.L.Rob. & Fernald) Freckmann & Lelong, stat. nov.—**20(1):**166

Dichanthelium oligosanthes subsp. **scribnerianum** (Nash) Freckmann & Lelong, comb. & stat. nov.—**20(1):**170

Dichanthelium ovale subsp. **praecocius** (Hitchc. & Chase) Freckmann & Lelong, comb. & stat. nov.—**20(1):**170

Dichanthelium ovale subsp. **pseudopubescens** (Nash) Freckmann & Lelong, comb. & stat. nov.—**20(1):**170

Dichanthelium ovale subsp. **villosissimum** (Nash) Freckmann & Lelong, comb. & stat. nov.—**20(1):**170

Dichanthelium sect. **Pedicellata** Hitchc. & Chase ex Freckmann & Lelong, sect. nov.—**20(1):**165

Dichanthelium portoricense subsp. **patulum** (Scribn. & Merr.) Freckmann & Lelong, comb. nov.—**20(1):**170

Dichanthelium sect. **Sphaerocarpa** (Hitchc. in B.L.Rob. & Fernald) Freckmann & Lelong, stat. nov.—**20(1):**166

Dichanthelium sect. **Strigosa** Freckmann & Lelong, sect. nov.—**20(1):**166

Dichanthelium strigosum subsp. **glabrescens** (Griseb.) Freckmann & Lelong, comb. & stat. nov.—**20(1):**171

Dichanthelium strigosum subsp. **leucoblepharis** (Trin.) Freckmann & Lelong, comb. & stat. nov.—**20(1):**171

Dichanthelium tenue (Muhl.) Freckmann & Lelong, comb. nov.—**20(1):**171

Dieteria asteroides var. **glandulosa** (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1393**

Dieteria asteroides var. **lagunensis** (D.D. Keck) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1393**

Dieteria bigelovii (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1394**

Dieteria bigelovii var. **commixta** (Greene) D.R. Morgan & R.L. Hartman, comb nov.—**20(4):1394**

Dieteria bigelovii var. **mucronata** (Greene) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1394**

Dieteria canescens subsp. **glabra** (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov. —**20(4):1396**

Dieteria canescens var. **ambigua** (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov. —**20(4):1396**

Dieteria canescens var. **aristata** (Eastwood) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1397**

Dieteria canescens var. **glabra** (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov. —**20(4):1397**

Dieteria canescens var. **incana** (Lindl.) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1396**

Dieteria canescens var. **leucanthemifolia** (Greene) D.R. Morgan & R.L. Hartman, comb. nov—**20(4):1396**

Dieteria canescens var. **nebraskana** (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1397**

Dieteria canescens var. **sessiliflora** (Nutt.) D.R. Morgan & R.L. Hartman, comb. nov. —**20(4):1396**

Dieteria canescens var. **shastensis** (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1396**

Dieteria canescens var. **ziegleri** (Munz) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1396**

Dioscorea lisae Dorr & Stergios, sp. nov.—**20(3):**1007

Eriogonum riograndis Nesom, sp. nov.—**20(1):**32

Eurybia glauca var. **pulchra** (S.F. Blake) Brouillet, comb. et stat. nov.—**20(4):1562**

Festuca cuzcoensis Stančík & P.M. Peterson, sp. nov.—**20(1):**22

Festuca dentiflora E.B. Alexeev ex Stančík & P.M. Peterson, sp. nov.—**20(3):**1016

Festuca tovarensis Stančík & P.M. Peterson, sp. nov.—**20(1):**24

Gentianella boliviana (Pax) J.S.Pringle, comb. nov.—**20(4):1486**

Gentianella inaequicalyx (Gilg) Fabris ex J.S.Pringle, comb. nov.—**20(4):1488**

Glandularia verecunda forma **albida** (Moldenke) B.L. Turner, comb. nov.—**20(4):1648**

Gonolobus tenuisepalus Krings, sp. nov.—**20(1):**105

Ipomoea costellata var. **edwardsensis** O'Kennon & Nesom, var. nov.—**20(1):**39

Ipomoea tacambarensis E. Carranza, sp. nov.—**20(4):1351**

Leandra urbaniana (Alain) Alain, comb. nov.—**20(4):1645**

Liatris elegans var. **kralii** Mayfield, var. nov.—**20(2):**601

Liatris elegans var. **bridgesii** Mayfield, var. nov.—**20(2):**598

Liatris elegans var. **elegans** forma **flabellata** (Small) Mayfield, comb. nov.—**20(2):**603

Liatris gholsonii L.C. Anderson, sp. nov.—**20(1):**98

Liatris patens Nesom & Kral, sp. nov.—**20(4):1579**

Liatris savannensis Kral & Nesom, sp. nov.—**20(4):1574**

Lithospermum hintoniorum B.L. Turner, sp. nov.—**20(2):**501

Matelea monticola Alain, nom. nov.—**20(4):1645**

Maytenus urbanii Alain, nom. nov.—**20(4):1645**

Medinilla anamalaiana Sasidharan & Sujanapal, sp. nov.—**20(1):**110

Meliosma chiriquensis J.F. Morales, sp. nov.—**20(3):**934

Meliosma clandestina J.F. Morales, sp. nov. —**20(3):**934

Meliosma depressiva J.F. Morales, sp. nov.—**20(3):**937

Packera texensis R.J. O'Kennon & D.K. Trock, sp. nov.—**20(3):**945

Panicum aciculare var. **neuranthum** (Griseb.) Wipff, comb et stat. nov.—**20(3):**1044

Panicum aciculare var. **ramosum** (Griseb.) Wipff, comb nov.—**20(3):**1044

Panicum acuminatum var. **ferventicola** (Schmoll) Wipff, comb. et stat. nov.—**20(3):**1044

Panicum acuminatum var. **thermale** (Bol.) Wipff, comb. nov.—**20(3):**1044

Panicum amarum subsp. **amarulum** (Hitchc. & Chase) Freckmann & Lelong, comb. & stat. nov.—**20(1):**171

Panicum anceps subsp. **rhizomatum** (Hitchc. & Chase) Freckmann & Lelong, comb. & stat. nov.—**20(1):**171

Panicum sect. **Antidotalia** Freckmann & Lelong, sect. nov.—**20(1):**163

Panicum capillare subsp. **hillmanii** (Chase) Freckmann & Lelong, comb. & stat. nov.—**20(1):**171

Panicum commutatum var. **equilaterale** (Scribner) Wipff, comb. et stat. nov.—**20(3):**1044

Panicum dichotomiflorum subsp. **bartowense** (Scribn. & Merr.) Freckmann & Lelong, comb. & stat. nov.—**20(1):**171

Panicum dichotomiflorum subsp. **puritanorum** (Svenson) Freckmann & Lelong, comb. & stat. nov.—**20(1):**171

Panicum hallii subsp. **filipes** (Scribn.) Freckmann & Lelong, comb. & stat. nov.—**20(1):**172

Panicum sect. **Hemitoma** Hitchc. & Chase ex Freckmann & Lelong, sect. nov. – **20(1):**163

Panicum hirticaule subsp. **sonorum** (Vasey) Freckmann & Lelong, comb. & stat. nov.—**20(1):**172

Panicum hirticaule subsp. **stramineum** (Hitchc. & Chase) Freckmann & Lelong, comb. & stat. nov.—**20(1):**172

Panicum ovale var. **praecocius** (Hitchcock & Chase) Wipff, comb. nov.—**20(3):**1044

Panicum philadelphicum subsp. **gattingeri** (Nash) Freckmann & Lelong, comb. & stat. nov.—**20(1):**172

Panicum philadelphicum subsp. **lithophilum** (Swallen) Freckmann & Lelong, comb. & stat. nov.—**20(1):**172

Panicum rigidulum subsp. **abscissum** (Swallen) Freckmann & Lelong, comb. & stat. nov.—**20(1):**172

Panicum rigidulum subsp. **combsii** (Scribn. & C.R. Ball) Freckmann & Lelong, comb. & stat. nov.—**20(1):**172

Panicum rigidulum subsp. **elongatum** (Pursh) Freckmann & Lelong, comb. & stat. nov.—**20(1):**172

Panicum rigidulum subsp. **pubescens** (Vasey) Freckmann & Lelong, comb. & stat. nov.—**20(1):**173

Panicum rigidulum var. **abscissum** (Swallen) Wipff, stat. nov.—**20(3):**1045

Parathesis pseudocalophylla Ricketson & Pipoly, sp. nov.—**20(3):**899

Parathesis pseudocrassiramea Ricketson & Pipoly, sp. nov.—**20(3):**902

Parathesis subg. **Laterales** Ricketson & Pipoly, subg. nov.—**20(3):**915

Parathesis subg. **Laterales** sect. **Calophyllae** Ricketson & Pipoly, sect. nov.—**20(3):**915

Parathesis subg. **Parathesis** sect. **Cubanae** Ricketson & Pipoly, sect. nov.—**20(3):**916

Parathesis subg. **Laterales** sect. **Laterales** Ricketson & Pipoly, sect. nov.—**20(3):**915

Parathesis subg. **Parathesis** sect. **Versatiles** Ricketson & Pipoly, sect. nov.—**20(3):**917

Polygonum aviculare subsp. **buxiforme** (Small) Costea & Tardif, comb. et stat. nov.—**20(3):**988

Polygonum fowleri subsp. **hudsonianum** (Wolf & McNeill) Costea & Tardif, comb. nov.—**20(3):**994

Polygonum humifusum subsp. **cauriana** (Robinson) Costea & Tardif, comb. et stat. nov.—**20(3):**995

Polygonum ramossisimum subsp. **prolificum** (Small) Costea & Tardif, comb. et stat. nov.—**20(3):**995

Polygonum sawatchense subsp. **oblivium** Costea & Tardif, subsp. nov.—**20(4):1637**

Polygonum striatulum var. **texense** (M.C. Johnston) Costea & Tardif, comb. et stat. nov.—**20(3):**996

Portulaca matthewsii G. Ocampo, sp. nov. —**20(4):1358**

Portulaca rzedowskiana G. Ocampo, sp. nov.—**20(2):**487

Pseudognaphalium biolettii A. Anderb. [nom. nov.]—**20(1):**149

Psidium salutare var. **decussatum** (DC.) Landrum, comb. nov.—**20(4):1463**

Psidium salutare var. **mucronatum** (Cambess.) Landrum, comb. nov.—**20(4):1463**

Psidium salutare var. **pohlianum** (O. Berg) Landrum, comb. nov.—**20(4):1466**

Psidium salutare var. **sericeum** (Cambess.) Landrum, comb. nov.—**20(4):1467**

Psychotria bulilimontis Takeuchi, sp. nov.—**20(4):1514**

Psychotria bulilimontis var. **aestuarii** Takeuchi, var. nov.—**20(4):1519**

Pteroceras monsooniae Sasidharan & Sujanapal, sp. nov.—**20(3):**923

Sagraea rugosa Alain, nom. nov.—**20(4):1645**

Salix exigua var. **sericans** (Nees) Nesom, comb. nov.—**20(2):**523

Schistocarpha calzadana B.L. Turner, sp. nov.—**20(2):**505

Senecio sandersiana B.L. Turner, sp. nov.—**20(1):**175

Senecio spribillei W.A. Weber, sp. nov.—**20(2):**511

Siphonandra boliviana Luteyn, sp. nov.—**20(1):**13

Solidago altissima subsp. **gilvocanescens** (Rydb.) J.C. Semple, comb. et stat. nov.—**20(4):1606**

Solidago arenicola B.R. Keener & Kral, sp. nov.—**20(4):1589**

Solidago ser. **Auriculatae** Semple, ser. nov.—**20(4):1606**

Solidago ser. **Drummondiani** Semple, ser. nov.—**20(4):1606**

Solidago faucibus Wieboldt, sp. nov.—**20(4):1596**

Solidago subsect. **Humiles** (Rydb.) Semple, comb. et stat. nov.—**20(4):1606**

Solidago kralii Semple, sp. nov.—**20(4):1606**

Solidago lepida subsp. **fallax** (Fernald) Semple, stat. nov.—**20(4):1611**

Solidago lepida var. **salebrosa** (Piper) J.C. Semple, comb. nov.—**20(4):1611**

Solidago subsect. **Multiradiatae** (Juz.) Semple, comb. nov.—**20(4):1605**

Solidago odora subsp. **chapmanii** (A. Gray) J.C. Semple, comb. nov.—**20(4):1611**

Solidago ser. **Odorae** (Mackenzie in Small) Semple, comb. et stat. nov.—**20(4):1606**

Solidago patula subsp. **strictula** (Torr. & A. Gray) J.C. Semple, stat. nov.—**20(4):1612**

Solidago puberula subsp. **pulverulenta** (Nutt.) J.C. Semple, comb. et stat. nov.—**20(4):1612**

Solidago rugosa var. **cronquistiana** Semple, var. nov.—**20(4):1612**

Solidago sempervirens subsp. **azorica** (Hochst. ex Seubert) Semple, comb. et stat. nov.—**20(4):1615**

Solidago sempervirens subsp. **mexicana** (L.) Semple, comb. et stat. nov.—**20(4):1615**

Solidago speciosa subsp. **pallida** (Porter) Semple, comb. et stat. nov.—**20(4):1615**

Solidago stricta subsp. **gracillima** (Torr. & A. Gray) Semple, comb. et stat. nov.—**20(4):1615**

Solidago velutina subsp. **californica** (Nutt.) Semple, comb. et stat. nov.—**20(4):1616**

Solidago velutina subsp. **sparsiflora** (A. Gray) Semple, comb. et stat. nov.—**20(4):1616**

Sphaeralcea caespitosa var. **williamsiae** N.H. Holmgren, var. nov.—**20(1):**49

Stylogyne pucuroensis Ricketson & Pipoly, sp. nov.—**20(3):**919

Symplocos kothayarensis Sundaresan, Jothi, Rajkumar & Manickam, sp. nov.—**20(3):**928

×**Taxodiomeria peizhongii** Z.J. Ye, J.J. Zhang et S.H. Pan, gen. et sp. nov.—**20(3):**1001

Thelesperma pubescens var. **caespitosum** (Dorn) C.J. Hansen, stat. nov.—**20(1):**91

Thelesperma windhamii C.J. Hansen, nom. et stat. nov. —**20(1):**91

Themistoclesia unduavensis Luteyn, sp. nov.—**20(1):**15

Trichadenia sasae Takeuchi, sp. nov.—**20(4):1522**

Weinmannia bradfordiana Z. Rogers, sp. nov.—**20(1):**180

Weinmannia condorensis Z. Rogers, sp. nov.—**20(1):**183

Xanthisma arenarium (Benth.) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1405**

Xanthisma blephariphyllum (A.Gray) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1403**

Xanthisma section **Blepharodon** (DC.) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1401**

Xanthisma coloradoense (A. Gray) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1403**

Xanthisma crutchfieldii (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1403**

Xanthisma glaberrimum (Rydb.) Nesom & O'Kennon, comb. nov.—**20(4):1586**

Xanthisma gracile (Nutt.) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1405**

Xanthisma grindelioides (Nutt.) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1403**

Xanthisma grindelioides var. **depressum** (Maguire) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1404**

Xanthisma gymnocephalum (DC.) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1404**

Xanthisma gypsophilum (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1404**

Xanthisma incisifolium (I.M. Johnston) Nesom, comb. nov.—**20(4):1585**

Xanthisma section **Havardii** (R.C. Jackson) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1410**

Xanthisma johnstonii (S.F. Blake) D.R. Mor-

gan & R.L. Hartman, comb. nov.—**20(4):1404**

Xanthisma junceum (Greene) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1406**

Xanthisma restiforme (B.L. Turner) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1405**

Xanthisma rhizomatum (M.C. Johnston) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1405**

Xanthisma section **Sideranthus** (Nutt. ex Nees) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1405**

Xanthisma spinulosum (Pursh) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1406**

Xanthisma spinulosum var. **chihuahuanum** (B.L. Turner & R.L. Hartman) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1408**

Xanthisma spinulosum var. **glaberrimum** (Rydb.) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1408**

Xanthisma spinulosum var. **gooddingii** (A. Nelson) D.R. Morgan & R.L. Hartman comb. nov.—**20(4):1408**

Xanthisma spinulosum var. **incisifolium** (I.M. Johnston) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1409**

Xanthisma spinulosum var. **paradoxum** (B.L. Turner & R.L. Hartman) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1409**

Xanthisma spinulosum var. **scabrellum** (Greene) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1409**

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Xanthisma viscidum (Wooton & Standley) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1410**

Xanthisma wigginsii (S.F. Blake) D.R. Morgan & R.L. Hartman, comb. nov.—**20(4):1409**

Xylorhiza linearifolia (T.J. Wats.) Nesom, comb. nov.—**20(1):**145

Yucca cernua Keith, sp. nov.—**20(3):**892

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Crawford, D.J. 1983. Phylogenetic and systematic inferences from electrophoretic studies. In: S.D. Tanksley and T.J. Orton, eds. Isozymes in plant genetics and breeding, Part A. Elsevier, Amsterdam. Pp. 257—287. [author's names in cap/small cap]

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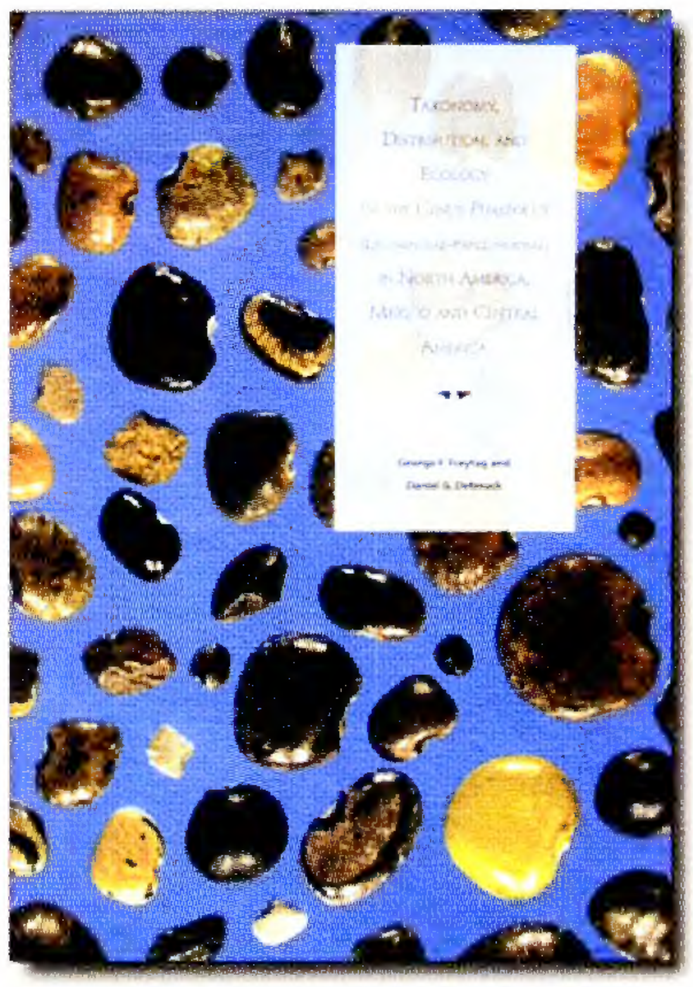
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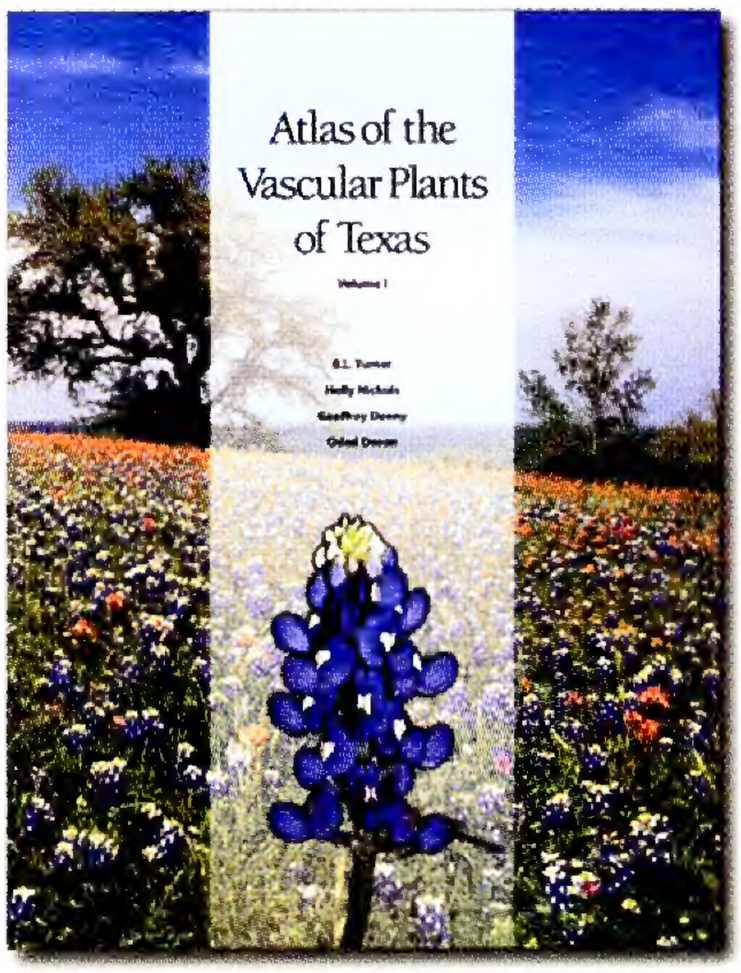
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